A STUDY AMONG THE BRASS WORKING COMMUNITIES IN EASTERN INDIA

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Abstract

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Metallurgy played a vital role in the development of civilization. Early evidence of metal alloy from eastern India is brass, an alloy of copper and zinc, in contrast to that of bronze in western India, the Indus Valley Civilization. In order to understand the technology of manufacturing brass product in the area, a study is conducted at a few selected places in eastern India. Selection of area is based on two factors, firstly evidence of early brass from the region and secondly, there are still a number of brass working communities engaged in manufacturing of brass article, some even follow the indigenous process of *cire perdue* method. The present study is on brass. An extensive literature survey is made for understanding the origin, nature and distribution of the early bronze and brass technology of the world. In the study of artisans, special attention is given on the socio-economic aspects, technology of production, mode of change among the craftsmen, their production and types of objects they made. Standard anthropological methodology is followed. Sources of data are two, one from the archeological context, and the other from the present day brass working communities. The artisans of the present day maintain their solidarity by marriage pattern as well as with the use of common technology. The organization of production is an important aspect of the craft. It also depends upon particular social set up in which the artisans are surviving by maintaining a symbiotic relationship with other communities living in the area. Making of brass objects need special skill which is traditionally learnt from one generation to the other. The techniques of making brass objects is primarily divided into two types, lost wax process of casting and other techniques. The metallurgy of brass originated in eastern part of India during Chalcolithic period of time (c. 2000 BCE). Types of alloy and technology of manufacture prove that it is indigenous in origin with regional specialization.

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PREFACE

Geographically India is considered as a separate subcontinent in the continent of Asia. It witnessed the invention and development of different technological traditions from prehistoric period. Metallurgy is one of them which played a vital role in the origin of civilization. Archaeological evidences show that the metallurgy of Harappan civilization had link with the West Asia, whereas there were different local traditions of metallurgy which developed independently in other parts of the subcontinent. The present focus is given on metallurgy of Eastern India with special emphasis on brass. There is a long history of brass rooted to Neo-Chalcolithic period and a number of communities still practice brass work in different areas of Eastern India. Technology of metallurgy is scientific in terms of its physical and chemical phenomena. In every stage scientific knowledge is essential starting from the identification of ores in natural deposition, quarrying, processing, casting and finishing.

No work exclusively on the tradition of brass work in Eastern India has so far been done. In present work archaeological evidences of copper and its alloy in India and other parts of the world have been taken into account to identify the uniqueness of brass metallurgy in Eastern India. The study is supported with archeological evidences of brass with a view to finding the genesis and continuity. Not only archeological evidences the study is also concerned with the people involved in brass work. The brass artisans are a specialized professional class of artisans who form a community and continuing their craft in a specific pattern of social organization. An attempt also has been made to identify the particular situation within which the traditional skill operates. These include caste, community, and occupation, social and economic stratification. The technological aspect include organization of production, the persistence of traditional tools, process of production, design, forms, market, transport facilities, communication facilities and change. Pictorial documentation on technology includes tools, manufacturing process, designs and motifs.

The present work is a continuation of the dissertation work on the brass ornaments unearthed from the site Kuanr in Keonjhar District of Odisha, done as a part of the M.Sc, Part-II Examination in the Department of Anthropology, University of Calcutta. The present research is partially funded by the DSA, Department of Anthropology, University of Calcutta and University Grant Commission (UGC), New Delhi.

The present study is unique which seek to present an analytical picture of brass work in terms of archeological, historical, social, economical and aesthetic aspects in Eastern India supported with empirical data and existing literatures. The study is an endeavour to yield many unknown facts about the origin and development of brass metallurgy in Eastern India and its present status.

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As I joined as an Assistant Professor of Anthropology in West Bengal State University before the completion of Junior Research fellowship of UGC, priority was given to my official duties. As a result the field work, analysis and writing up thesis were slowed down. I am grateful to Prof. Falguni Chakraborty of Vidyasagar University, who had continuously encouraged me to finish my work without delay. I render my gratitude to my teachers from school level to post graduate courses.

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Friends and relatives extended all kind of help of help and assistance. The author is not thanking them by name but with heart. Without the continuous encouragement and guidance of my beloved parents late Prasanta Kumar Mondal and Mrs. Sandhya Mondal this work would never have been completed. They had been my inspiration and support from my childhood. I am grateful to them and offer my deep respect to them. I am also thankful to my maternal uncles and maternal aunts, especially late Anata Biswas, who also helped and guided me from my school days.

Last not the least I thank all associated in any sphere of the present research.

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CHAPTER I

1. INTRODUCTION

1.1 About the work:

Present research and thesis is on the craft of brass and on the status of the craftsmen of brass. The research is undertaken with the purpose of understanding of the present situation of the craft and craftsmen and at the same time to throw some light on the ancient brass technology of the past, that are found in Eastern part of India.

Though people outside the metal working community are familiar with different brass objects and their utility, but they seldom connected with the artisans who are engaged in brass work and different aspects of technology. The curiosity about these craft and craftsmen is limited and the technology, skill, materials, tools connected with the craft mostly remains in darkness. A number of studies have been carried out about these aspects, separately or in combination from different disciplines. As an anthropological study present research is an endeavour that not only focuses on the technology but also the craftsmen in Eastern part of India in the background of the development of metallurgy especially brass in India and also around the world.

Anthropology is the study of humanity from its prehistoric origin to contemporary diversity. The inventions of different new technologies enable man to live on this earth more securely than the earlier time. The bio cultural evolution of man was revitalized with these new innovative technologies and revolutions occurred in different cultural stages of human past. After the long prehistoric Stone Age, invention of metal by early man became a hallmark of the civilization. Invention of metallurgy was the prime factor in the transition from Stone Age to Metal Age. The discovery and advent of metallurgy indicates a great step in the history of mankind and forms the only part of that "prelude to urban revolution" as proposed by Gordon Childe (Forbes 1950).

The food producing economy and settled way of life in the Neolithic period ensured the growth of different crafts like pot making, bead making, bone and ivory working, terracotta objects making, weaving, carpentry and metal working. Out of these metal working was the most outstanding invention paving paths to the civilization. At the last phase of the Stone Age Neolithic men discovered metals that occur in pure form in the nature. At the earlier stages men collected native metals, such as copper, gold and meteoric iron which occur naturally on the earth. At first it was simply treated in the same way, as earlier raw material like stone. Before long it was realized that the 'strange stones' have some varied individual properties and are good for making implements.

Prehistoric men took long time to know the properties of the metals and select these odd stones for the artifacts they made. According to the eminent material scientist Cyril Stanley Smith (1981) metallurgy was adopted not from some technical or economic necessity, but from aesthetic and specific socio-cultural desire. "People did not *need* copper tools; they *wanted* copper tools" (Roberts *et al.* 2009). As metal was not considered as superior and not easily available, earlier raw materials namely stone, bone, ceramics continued in everyday task for thousands of years along with the metal tools. The advent of metal technology reversed the early phenomena and metal dominated over stone through time. Metal technology needed different stages, beginning with procurement, mining to the final shaping. To manage everything related with metal a small body of skilled men was formed. They were the smiths; an elite class of artisans specialized in different metal works. They were divided into groups on the basis of to their specialization, such as copper smith, bronze smith, brass smith or iron smith. The advent of metallurgy depends on the good quality of metal ores which are not available in every parts of the world. Due to unavailability of raw materials suitable for metal work early people had to depend on others and longer trade routes were established compare to earlier times. Men first used native metal then they learnt the process of making alloy that were harder and better to cast. Copper appears to be first metal widely used by man. There is a long history of the development of copper alloy in different parts of the world. Gradually early metal smiths learnt the technology of processing alloy by adding tin, zinc, antimony, or other metals to copper. For the present study brass, an alloy of copper

and zinc has been taken into consideration. The reason for taking up brass for the present research is that in eastern India there are evidences of presence of brass in Chalcolithic cultural stage (Ray *et al.* 2013).

The brass with 10 -18% of zinc have golden yellow colour. Due to excellent machinability, strength, ductibality and corrosion resistant, brass has been widely used for fabricating vessels, casting of statues, metal idols and ornaments. Brass is favoured for its luster and shiny gold look. A number of brass products are used in different contexts of daily life, namely, cooking, storing, ritual purposes and also for decorative items. The technology and people who were connected with the craft in the past are mostly remained in darkness. Making of metal objects is scientific in terms of physical and chemical phenomena. Scientific knowledge is required in every stages of production from the collection of ores, smelting, casting, shaping to finishing of metal items. The knowledge, skill and expertise connected with different phases of metal technology are transmitted through generations.

In India brass artisans comprise a group with its placement in hierarchical position of social structure. The social position of brass artisans varies from one area to the other in this country. Sometimes social position also varies according to the technology in the same district or region. The brass artisans form a number of different endogamous groups with specific pattern of economic activities in this country.

In prehistoric period brass was regarded as valuable metal and its use was limited mostly for ornaments and ritualistic purpose as the evidences are found from archeological context. There was wide use of brass objects from daily use to religious rituals in the earlier decades. The situation is under the fast and radical change. At present due to scarcity of raw materials and high price the brass objects are being replaced by low costs and cheaper materials. Despite this, artisans are continuing brass work in very adverse situation and the craft is declining rapidly. The present status of the craft is dying one. In case of lost wax process of metal casting the scenario is quite different.

The retrieving this brass craft with its totality is necessary before wiped out and shifting of the craftsmen to other occupations. It is worth to study this craft with change and development as well as covering the aspects of technology and the prevailing social condition in which the craft is being continued.

The area selected for the present study is Eastern India. The area falls under four major geo-political units in the states of West Bengal, Bihar, Odisha and Jharkhand. All these states are not only form administrative units; but there are differences in terms of geomorphology, ecological settings, language and people. The region has also yielded a number of Chalcolithic sites and also has yielded evidence of brass from early times.

A number of villages and towns famous for brass craft have been selected from different parts of the regions for the present study. All these areas have been studied intensively with settings, amenities, people, culture and demographic aspects. The people of the selected area both metal worker and others have been taken into consideration with a point view to highlight how the craft is being continued by maintaining symbiotic relations with other castes and tribes lived in the area.

In the present work there is a scope of viewing of the condition and techniques of brass work and at the same time ideas can be made about the artisans of the prehistoric and protohistoric times. At the same time study on the artisans living in the area could be made. For the purpose of understanding brass of the past, the present study has been undertaken on brass artisans and their craft in the area.

The study also covers holistic study of technology and on such relevant features as raw materials, techniques, form and function of products. Data has been collected through extensive fieldwork in the area. Secondary sources for data are utilized. Final analysis and interpretation is done on the basis of objectives of the study.

1.2 Background of the present study:

The present topic was selected from personal interest on brass. There is a continuation of the dissertation of M.Sc Part-II examination of Anthropology of University of Calcutta. The evidence of brass from eastern India was discovered by Prof. Ranjana Ray of Department of Anthropology of University of Calcutta. The project entitled "A study of Neolithic-Chalcolithic cultures of Keonjhar and Mayurbhanj districts: A search for indigenous people" was taken under the DSA programme of the said department. The present study is an elaboration of the earlier work both in archeological context and present day brass working. An attempt is being made to highlight the distribution of the brass work in different regions of the studied areas. Samples have been taken from different districts and states of the eastern part of Odisha. The existing literatures and documents from Government officials also helped to know the distribution of the craft in the region, its history, development and change. An attempt has been made to find out the primacy of the brass in the area. For this purpose the findings of the brass objects of the past have been taken from archaeological literatures.

Time, money and people are also important resources of a research project. For the present study maximum time was spent for the fieldwork and rest for discussion with supervisors, analysis of data and writing of report. The project was partially funded by UGC and rest expenditure has been done by the researcher. Except myself People who are directly or indirectly involved in the research are teachers, academicians and also upcoming scholars in the field. Students and scholars helped in data collection and computation of the data.

1.3 Objectives set forth:

As an explorative study, aims and objectives of the present research are as follows:

- To study the origin, development of brass alloy and the communities related to the brass craft in the light of archaeometallurgical history of Eastern India.

- To study different aspects of technology of brass craft and the organization of production within a socio-economic system.
- To understand how the variation of production and techniques are influenced by existing cultural norms and desires of individual and communities.
- To investigate particular social situation responsible for the slow transformation of the craft and changing aspects under the present situation.

1.4 Review of existing literature:

To understand the distribution of brass work worldwide both past and present and to reconstruct the development of brass metallurgy and its position in eastern India, existing literature on archaeometallurgy as well as contemporary metal and mining technology are surveyed as far the author has been able to ascertain. The literature includes articles in research papers, periodicals, journals, books and Government records both published and unpublished with web sources. Beside brass work literatures regarding the copper and bronze also have been taken into account, because these are related metals and sometimes both are present to make an alloy. Though archeologists and anthropologists are directly associated with archeometallurgy, experts from various disciplines like geology, geography, chemistry, history, and metallurgy tried to contribute their knowledge and practical researches in this field to unfold different hidden facts of development of metallurgy both worldwide and localized.

a. International studies:

Those years observed the birth of archaeometallurgy, when there is series of publications by Ronald Tylecote and Radomir Pleiner (Tylecote 1962; Pleiner 1967). These works inspired a number of archeologists and archaeometallurgists to research in this field (Cleere 1997). However the root of these researches goes back to 1888, when V. Ball published his paper on brass casting in India.

Henry Balfour (1910) wrote a paper on modern brass-casting in West Africa. He concentrated on *cire perdue* method of casting. In this technique the molten wax from the core is drained out first, and then the molten metal is poured into it which fills the gap left by the molten wax. In this process of casting the mould and metal for casting are not fired together.

Gowland (1912) reported early occurrence of metals in antiquity. Hough (1916) is of opinion that metallurgy was developed with the invention and achievements of controlling of fire and directly associated with the concentration of heat. He also pointed out that three metals used by early man are copper, silver and gold. Gradually fourth metal was developed as an alloy i.e. bronze, the alloy of copper and tin, and then iron. During the early stage of the Metal Age, the ores of copper, and its alloys with tin, nickel, antimony and arsenic, etc. were obtained from the surface ores, the mining was started later.

Thomas (1918) gave a short description of brass work in Edo in Nigeria. The brass workers were descended from the Kings of Ufe and they were experts in lost-wax process of casting. The brass was obtained from European sources. In the old days different brass articles were produced and used for household or ceremonial purposes. Wooden dishes ornamented with brass were used for the kings. The modern items were made from inferior metals, badly modelled than the older types and mostly made for sale to Europeans.

George Brinton Phillips (1922) noted the presence of remarkable percentage of zinc in some bronze objects. These are primarily brass though there are small percentage of tin. It is also very interesting that iron is also present in different bronze objects. Zinc is present in 0.17% in Greek Bronze object dated to 600 BC, 31.99% in Chinese bronze dated to 200 years, and 15% in Tibetan Bronze.

An article on brass casting in the Central Cameroon of West Africa was authored by Malcolm (1923). A number of indigenous communities practice *cire perude* method

of brass casting there. They generally practice solid casting and their position in the tribe was as attendant to the head chief. The brass used in the craft was of Europeans origin.

Among other pioneer works in the field of archaeometallurgy are notably done by Oliver Davies on mines in Europe (Davies 1935), H. H. Coghlan’s on old world metallurgy (Coghlan 1951), Joseph Needham's study of the metal technology of ancient China (Needham 1954), the early history of the science of metallurgy by Cyril Stanley Smith (Smith 1960) and R. J. Forbes's work (1950) on worldwide development of metallurgy.

Maryon (1949) reconstructed the process of metal working in ancient world with the materials collected after the excavation of Royal cemetery in Ur in Mesopotamia dated to 3500 to 3000 B.C.E. Different process of making hollow bowls were discussed including charcoal firing, annealing, sinking and raising, spinning and riveting, repousse decoration etc. For the production of a number of copies of a pattern in relief, dies or moulds might have been employed. The ancient smith was called upon to produce the tools and the weapons, the domestic appliances and the jewellery of his community.

The metallographic examination of metallic zinc of Athens is done by Farnsworth *et al.* (1949). The study reveals that zinc was smelted in India and China earlier than Europe. The earliest use of zinc in Europe was in sixteenth century.

The distinctive work of Forbes (1950) was based on linguistic and literary sources. The central focus of his study was on Near East but he also mentioned different areas worldwide to know the origin, diffusion and development of different metal tradition including India. Beside zinc and brass he also emphasized on copper, tin, bronze, iron, gold and silver. The emphasis also has been given the evolution of smith and his social status. The history of brass and zinc also was given with literary meaning, geology, collection and smelting process of zinc ores, chemical composition, preparation of alloy and diffusion of technology.

Gordon (1950) is of opinion that copper was introduced in Indus Valley from the West by the peasant communities around 2800 BCE and succeeded a purely Mesolithic

people. The Harappan people have large range of equipments of copper and bronze with a good knowledge of metallurgy. They were followed in Northern India by the invasion of people from Iran with weapons of copper and bronze of Bronze Age type. It may be noted that Pre Harappan cultures of the region were not properly understood at that time.

Morgan (1951) studied about the technology of brass work in Trengganu. The methods mainly used to make cooking pots by casting method. The processes are traditional in nature and remain unchanged for several hundred years.

Hawley (1953) described the manufacturing process of copper bells in Southwestern sites. These copper bells had been found in south central and eastern Arizona. Western New Mexico belongs to Pueblo period. The origin, development and manufacturing process became puzzles to the archeologists. The metallurgical analysis and typological similarities prove that the bells were made by casting of copper in Mexico and brought through prehistoric trade root. Author also argued that prehistoric bells of America were made by *cire perdue* method of casting and small metal objects were made by *cire perdue* process in Renaissance period in Europe and also in Ancient North Africa, China and India.

Bromehead (1954) gave an account of early mining of copper. According to his study tin was imported in the eastern Mediterranean from Britain in Middle Bronze Age. Copper used by Sumerians of southern Mesopotamia was imported from Asia Minor, Armenia and Elam as early as 3500 to 3000 BC.E. Assyrian traders had their agencies in Asia Minor and bought two types of copper 'bad' (black) and 'good' (refined). The price of 'bad' copper is half of the price of 'good' copper. The shape of the ingots was ox-hides. The production was at peak between 2400-2000 BC and 1500-1200 BC. Though there were some copper mines in the Eastern Desert of Egypt, the greatest quality comes from the Sinai Peninsula. Copper was also imported from Cyprus and Armenia about 1200 BC. Other important copper mining centers were Arabah between the Dead Sea and the Gulf of Aqaba. In Cyprus copper mining begun in the second half of Third Millennium BC. Both sulphide and oxide ores were in full use and supplied to Egypt. Mines also have been noticed from Troy, Crete and Greece. In Europe copper mines were

found in Austria, Germany, France, Spain, Portugal, Greece, Southern Russia dated to Bronze Age. There is also a description of mining technology highlighting the ventilation, ladder to get down, water supply, miners lamps and tool used mostly shovel and bronze hammers in the mines. The ores were crushed by wooden hammer, sieved and brought up in leather bags.

Coughlan (1954) reconstructed the technological evolution of implements and weapons mainly made of copper and its alloy. In prehistoric period copper was obtained from its ore with 99% purity. As pure metal is very soft, prehistoric technician increased its hardness by cold working, such as hammering. The excess hardness was removed by heating, i.e. annealing. Weapons were produced by alternating annealing and hammering. The method of casting was introduced in Egypt as early as 4th Millennium BC for making flat celt. Celt with shaft hole, chisel, saw were common metal tools. The technology was different among Egyptian, Sumerians and Indians. Common weapons were dagger, battle axe, spear head and arrow head. With the introduction of bronze different types of casting was possible, such as open mould, closed mould and cire perdue. In Bronze Age the variety of metal tools was increased. These include hammer, anvil, different types of celt, chisel, blade and drill. The weapons made of bronze were dagger, halberd, sword, spear heads, arrow head and battle axes. The cire perdue method of casting was mainly used for making ornaments.

Gray (1954) discussed about the transition from bronze to iron. In Anatolia it begun around 1300 BCE and after a century in Greece, and ended around 700 BCE. This transitional period is characterized by a number of events. Such as limitation of iron in Late Bronze Age, simultaneous appearance of bronze and iron objects for the same purpose, inlaying of bronze objects with iron, combination of iron working and bronze ornamentation in the same weapon, addition of iron working in parts to bronze objects, use of bronze screws on iron weapons and tools and repair of bronze objects with iron parts.

Maryon and Plenderleith (1954) focused on fine metal work as a type of craftsmanship as evidenced from riverine civilizations of Mesopotamia and Egypt. There

is a description of skill of annealing, moulding, casting and working in sheet metal. Annealing was developed in the Fourth Millennium BCE. To prevent the hardness during cold work ancient craftsmen could soften it by firing i.e. the discovery of annealing was made. In the ancient world axes and other metal objects were cast in open moulds made of stone or baked clay. Later two-piece moulds were used. Europeans became masters of this craft. A number of hollow cast statues have been found from Egypt. *cire perdue* process was applied in China and there is a set of inscription at the bottom of the vessels. Statues of wrought iron like copper bull, copper panels were found from Mesopotamia dated to 3000 to 2500 BCE. Decoration including relief work or repousse, chasing or surface decoration and engraving also have been described in the study though mainly highlighting the gold work. Same techniques are applied in metals wares made of copper and its alloy. Soldering or joining of different parts and welding also are important aspect of the craft. Joining was done with alloy which have low melting points than the pieces joined together. Welding was practiced to join separate pieces of metals by heat or mechanical treatment.

In the article of V. G. Chide (1957) Bronze Age was considered as technological stage when people used metals for preparing of tools in Europe. In Mesopotamia and Egypt there are economical and social preconditions for development of metallurgy, though the sources of copper was not available in alluvium plains. Beginning of metallurgy in these areas coincides with “urban revolution”. However in Europe the sources of copper were available and they were capable to utilize these metals. In the New World though there are good sources of metal, but there is deficiency in expertise for identifying and utilization of these metals. The use of metal expanded the international trade and development of full time specialists for collection, procurement and making of metal objects. According to Childe American Indians discovered metal, but they treated it as stone. The author also stated that the European Bronze Age industry developed later than that of oriental.

R. F. Tylecote (1962, 1987 and 1992) wrote a number of books on history of metallurgy in Europe. The emphasis was given on brass and zinc metallurgy in his

writings. According to his study brass did not appear in Egypt until about 30 BC. After that it was adapted throughout the Roman world rapidly. At first brass was produced by calamine process. Metallic zinc (high percentage of zinc) was introduced in China then entered into Europe. Brass with 20-30% of zinc was widely used for roman coinage. It also have been mentioned that zinc was widely produced in Zawar mines in India between 10^{th} and 16^{th} centuries. Zinc produced by distillation process was started from early medieval time in the area.

The study of C. C. Lamberg-Karlovsky (1967) on the metal technology of Indus Valley civilization shows the development of technology from cold hammering (4800 BCE), casting of open mould (3250 BCE), casting in closed mould, then *cire perdue* technique. In Pakistan and Afghanistan metal appeared around c. 3000 BCE. People there also knew the technology of raising, hollowing, sinking and soldering. The author also is of opinion that tin is rare in geological deposits in India. It is deposited only in Hazaribagh district. Tin was exported from West Afghanistan and Oman. Cooper was also imported from Afghanistan, Baluchistan and Oman through the port of Lothal. The composition of metals and its alloy shows that these were imported from different regions and the proportion of metals in different alloy are not uniform throughout the civilization.

Bray (1971) has traced the ancient metal smiths of America. The study highlighted the technological aspect of casting and is not concerned with typology or problem of chronology. Axes of copper and its alloy were found in numerous quantity in Middle America. Open moulds were generally used for casting in South America. Lost wax process of casting was common both for copper items and gold ornaments. They were also experts in sheet metal work and made vessels by pressing in concave moulds and by hammering. Alloy was also made with copper, gold and silver locally known as *tumbaga*, which was common throughout the world. Awls, chisels and axes were made from this alloy by cold hammering. There was also different status between the smiths who made personal ornaments from precious metal and the smiths who made copper or bronze tools and weapons used by common people. Metal industries developed around the edges of Maya lowlands. The archaeological findings of metal objects shows that the

metal objects were common in manufacturing areas of highland Guatemala and low land province.

Dark (1973) studied brass casting in West Africa. Casting of brass is generally done by open or closed mould. Open mould method of casting is generally practiced in West Africa and Congo. The closed mould technique is done as per the principle of *cire perdue* method of casting. There is a difference between the techniques used by different communities.

The study of Herbert (1973) on the use of copper in pre-colonial Africa was based on Museum collection, archeological evidences and existing literature suggests that copper and brass was imported, though there are a few copper deposits in the area. The author divided the use of copper and brass into four major categories: as a medium of exchange, as objects of personal adornment, as emblems of status and kingship, and as objects of cult in a narrower sense, though the uses of copper were many and changed from time to time and from place to place. The author also gave the reason behind the preference for copper and brass over other metals. He said that it was for the magic and the ritual properties ascribed to it, as well as for scarcity and aesthetic aspects. Copper and brass were also linked with cosmological aspects i.e. in the Middle Niger copper is explicitly linked with the spirit de l'eau and with myths of creation, while in the Niger Delta brass is associated with the water spirits.

According to the study of Wertime (1973) the upland belt and river valley of South west Asia have priority for the beginning of metallurgy and forces of urbanization contributing to the rise of metallurgy. He also opined that the evolution of metallurgy can be understood in the interrelation between process of diffusion and multiple innovations in Eurasia. He also mentioned that brass was manifested in second millennium.

Te-kun (1974) studied the development of metallurgy in China. According to the author Chinese bronze metallurgy was indigenous in nature. Bronze casting was invented in the time of Shang period. Their practice of casting is different from those of other parts of the world. The casting was done in piece mould with molten metal directly from the

furnace. They were not familiar with other technology like annealing, raising and *cire perdue* technique.

Craddock (1979) wrote about copper alloys of Medieval Islamic world. The author opined that brass was produced by cementation process i.e. alloying of copper and zinc ores in closed vessels. This is known as cementation process which was first used by the Romans in Asia Minor and then throughout the Medieval world both by Islamic and Christian people. He also argued that though the cementation process was introduced in Europe and Middle East, but the reduction of zinc by distillation process was started in India and China as early as ninth or tenth century AD.

Heron (1980) described the crisis of the craftsmen due to the transformation from the self-employment status to the position of working under an employer in the nineteenth century in Hamilton city in Canada. An assessment of the response of the craftsmen to the new technology and management system was taken. There were two largest metal working crafts; moulders and machinist in Hamilton city. Moulders had deepest root in the pre-industrial society from which skill of metal casting was transmitted in machinery, casing and ornamental brass and iron work. The study covers a wide area from the living and working condition of the craftsmen to the social and ideological phenomenon of the artisans in the clash between artisanal culture and industrial capitalist rationality. The working condition such as smoky workshop, ventilation etc. and the social condition such as independence and determination to resist subordination, personal liberty and freedom in workshop and society are discussed vividly. At the end of the nineteenth century the power in the shop-floor was being challenged by employers when they realize that the power of these craftsmen is indispensable for larger corporate strategy. Trade unions were constituted that stipulated the areas of recruitment through apprentice, wage rates, daily work load and hours of work. Above all it is an essay about the history of the artisans from the pre- industrial stage to industrialization.

The archeological evidence of metallurgy in Mesopotamia came up between 5500 and 2100 BCE (Moorey 1982). The evidences suggest that metal like copper and lead

were imported from West or North West. The Mesopotamian smiths procured these as their requirements and in most of the cases the metals were reused. They have well developed bronze metallurgy.

Craddock *et al.* (1983) gave an account on the distillation process of zinc in Zawar, situated in Aravalli hills in Udaipur, Rajasthan in India. They reconstructed the technology of distillation process of zinc with the archeological remains of furnace, retorts and other associate findings. The retorts from old Zawar are cylindrical in shape approximately 30-35 cm long and 10 to 15 cm in diameter, tapering to a point at one end. The condenser was fixed to the open end with clay fired in a furnace of about 60 cm diameters for many hours at about 1100^0C. This technology was unknown in the West and in late Seventeenth century Europe it was imported from the East.

Weisgerber (1984) studied about the contact of Indus valley with Oman in connection with the copper production in third millennium BCE.

Gale *et al.* (1985) studied alloy types of copper artifacts in Anatolia. The study was done on chemical analysis and the result shows that the alloy was primarily copper-arsenical alloy and zinc is present in very negligible amount in few artifacts.

Muhly (1985) studied the sources of tin and about the introduction of bronze metallurgy in Europe, the Mediterranean and Western Asia. The distribution of worldwide geology of tin deposition shows that there is no considerable deposition in India.

Tana (1985) worked on the use of scrap metal in Africa. The different metals like copper, brass was imported and the artisans reuse these materials to make different new objects. The metals were imported from Europeans and before that from sub-Saharan trade route. The author raised a number of questions regarding the practice of use of these scraps metals. Perhaps they avoided use of locally available metals. Some other explanations may be these were easy to use, easy to procure, not much laborious, fascination behind imported metals etc.

The comments of Silverman (1986) regarding the Bono brass casting is that Bono initiated the lost wax process of brass casting in Asante in West Africa. Brass objects were used as symbol of trade and status. Due to decreasing demand of the brass they shifted to gold work by lost wax method of casting. Fox (1986) in the same year also contributed about the brass casting of Asante in Ghana, Africa.

Stech and Pigott (1986) threw some light on the metal trade in Southwest Asia in the Third millennium BCE. Tin was regarded as precious metal because of its rarity. People exchanged it for other exotic materials like lapis lazuli. The earlier occurrence of tin was found in Anatolia, from where it was traded to Mesopotamia.

The research of Natapintu (1988) was on copper-base metallurgy in Thailand. A number of sites were explored and excavated in Northeast Thailand and Central Thailand. These sites yielded a number of remains of early metallurgy like ores, fragments of crucibles, moulds, slag and charcoal with artefacts made on copper or bronze. A number of copper production sites were discovered from Khao Wong Prachan Valley. The primary copper ores collected were malachite and technique was ore crushing. The site Non Pa Wai was the largest copper production site in Thailand. There were parallel evidence of smelting of copper and burials. One such burial is known as "The Metal Worker's Grave". In conclusion the author made a comment that the copper-based metallurgy was developed in mainland Southeast Asia by the Second Millennium BCE.

Bennett (1988) studied copper smelting of prehistoric period in Central Thailand. She emphasized on technical aspects from the perspective of archaeometallurgy. The author shows the smelting was done in crucibles or "reaction vessel". The study is unique in the sense that smelting is rare in the history of metallurgy. The study was concentrated at Lopburi area, which was a centrally important copper smelting site and the ancient smelters preferred to use the sulfide ores. The microscopic examination indicates that copper artefacts, ingots were permeated by small copper sulphide inclusion. Copper was smelted in large crucible and ceramic moulds were used for casting metal ingots. The arsenic present in the ores produce poisonous oxide fumes, and inhalation causes health hazards to the metal workers.

Kennedy (1991) presented an important article on the use of brass in prestigious ornaments in Zulu kingdom (ca. 1800-1879) of South Africa. Different brass ornaments were used by hierarchically organized society and there was also prohibition of wearing these by others. There are also some objects worn by military man. Brass ornaments were also used as symbol of unmarried, married and pregnant women. The use of these metal ornaments gradually diminished to protect the European metal traders.

Scott (1991) gave a detail account on microstructure of metallographic analysis of different metals used in Ancient and Historic period. According to the study most of the brass used in antiquity was made by cementation process and the proportion of zinc does not exceed 28%. In this process zinc ore was mixed with copper ore and smelted together so that it was absorbed into copper during reduction in at 907^0C. There is also a categorization of zinc i.e. alpha brass (up to 35% of zinc), alpha + beta brass (35%-46.6% of zinc), beta brass (46.6%- 50.6%). In most of the ancient objects alpha brass which is better for cold work and annealed was used. It is unsuitable for hot work because the impurities segregate the boundaries and make the brass weak. In Java and Korea use of bronze became less with the introduction of brass technology. Roman coins were prepared from brass rather than from bronze.

An anthropological study of African metallurgy was done by Childs and Killick (1993). The study highlights the ethnographic data, social organization of production, symbolic and cognitive aspects of metallurgy in preindustrial African societies. Though the study is based on iron working, the author also highlighted that brass and copper was imported in sub-Saharan Africa. The archeological evidence also proves that iron was the first metal appeared in sub-Saharan Africa.

The history of indigenous metal working in sub-Saharan Africa was done by Miller and Merwe (1994). The history of brass started from the colonial period and before that 'Bushman' miners traded copper. At the beginning of colonial period copper, brass was traded from Dutch and English. Although few brass artifacts were noted in archeological record in South Africa, but zinc was not local origin, rather long-

established source from India. Lost wax process of brass casting was also practiced in West Africa.

An Anthropo-archeological study of social mining was done by Knapp and Pigott (1997). The Socioeconomic, spatial and ideological dimension of mining was highlighted both in past and present context. As an anthropological approach the economic, ideological and organizational aspects of mining were discussed with suitable examples. The mining communities have high fertility due to child marriage, low rearing cost of children, and minimum number of females in labor force and maintenance of sexual taboos. There is also division in classes and on gender roles among mining communities. Such aspects of the past mining communities also were reconstructed with the analysis of material remains.

McKeating (1997) wrote about metal work of Africa based on the collection of Cambridge University Museum of Archaeology and Anthropology (CUMAA). The author showed that there was well developed brass technology among a number of West African societies, including Benin and the Grass- fields chiefdoms of Cameroon that were formerly tied to the central political and religious institutions of those societies.

Slusser *et al.* (1999) gave a brief account on the sheet metal work for making sacred images in Nepal. Though the exact date is unknown but the presence of such work at present throws light on the history of earlier times. The study was done on the basis of data from the museums and in comparison with present day practice of making copper and brass objects as household craft. In earlier times images were made by lost wax method of casting and the repousse work is younger in origin. The craftsmen who are expert in making images and temple adornments by repousse work are distributed in the Kathmandu Valley. They are artisans as well as artists. The craftsmen who are known as *tamrakars* are expert in copper and brass work. Copper is a metal and brass is an alloy of copper and zinc were considered as pure metals as these are used in temples and shrines. Different images of God and Goddess are made by repousse work as a fine metal work side by side with antique items and utensils for domestic use.

Stech (1999) studied early metallurgy in Mesopotamia and Anatolia. In Anatolia metallurgy started with the evidences of native copper, which was probably a byproduct of the search for malachite from Neolithic period. Smelting of native copper was not in practiced until late seventh millennium. In Mesopotamia there is no native copper. Copper artifacts have been found from Sixth millennium. Pure copper, arsenic copper and tin bronze were common in both Mesopotamia and Anatolia by the early third millennium. In most of the cases bronze objects were found from the graves in Southwest Asia. The bronze consumption was declined in the second millennium. The sources of the tin were Afghanistan and regarded as precious objects and indicate status. There was a transformation of the village based societies of Early Bronze Age to Urban concentrations into the Middle Bronze Age in Anatolia. There was no evidence of brass or zinc in early metallurgy here.

Muhly (1999) focused on copper and bronze in Cyprus and the Eastern Mediterranean. Native copper was extensively used in Late Neolithic in Greece or Chalcolithic in Cyprus. Early Bronze Age was marked with the introduction of the mining and smelting of copper ores and alloy of arsenical copper. Bronze was occurred with copper arsenic alloy in Mesopotamia, Syria, the Levant, Cyprus and Anatolia area and tin was supplied from central Asia and Afghanistan through seaborne trade. The metallurgical history of the area is also devoid of brass or zinc metallurgy.

Piggot (1999) made his opinion on the development of metal production on the Iranian plateau. Native copper was initiated in Neolithic period and continued to Chalcolithic period. During the Chalcoithic period the use of arsenical copper was expanded and also continued in Bronze Age. A large number of crucibles which have a vital role in copper production were found from different sites of Iranian plateau.

In the introductory comment of the same volume V. C. Piggot (1999) also highlighted on the development of metallurgy of the Asian old world. The tradition was started with the use of native copper, which developed to arsenical copper metallurgy. The tradition of arsenical alloy was widely distributed across Southwest Asia into central

Asia and also common in Indus Valley tradition. Then the vast area was experienced with the tin and tin bronze metallurgy which dip into the later periods of time.

A historical approach of effect of capitalism on mining in Latin America was given by Dore (2000). There was copper, zinc and lead mines in America. The study is concerned with two aspects like labour conditions in the industry and second is the destruction of environment which had tremendous effect on mining in Latin America.

Craddock (2000) studied about the development of furnace types used in metallurgy in the Eastern Mediterranean. The development of metallurgy in Near East and Eastern Mediterranean from Neolithic to Bronze Age is always related with the pyrotechnology. The kiln of smelting metal is different from potters' kiln. Earlier copper was annealed in ordinary fire and the surface became oxidized. When copper was melted in crucible it was covered with charcoal to reduce oxidation. The melting of metal is related to use of charcoal. Then the cylindrical was furnace developed for better controlling of fire. This furnace types developed into shaft furnaces with the use of bellow from the end of the Bronze Age. This type of furnace is also common in India. The use of charcoal is replaced by the use of coke in Europe from 18th Century.

Weisgerber and Willies (2000) studied about the use of fire in ancient mining. The authors showed with illustrations and evidence of setting of fire in different mines in Europe, Middle and Far East for mining different stones and metals including copper, lead and tin. The metal ores were collected by hammering after being loosened by firing.

Nevadomsky (2005) wrote a paper on brass casting in contemporary Benin art of Africa. The tradition of brass art is also practicing to make different folklore figures as well as decorative items. They practice both traditional *cire perdue* method of casting to prepare small objects and casting in mould is generally for larger objects like statues. Brass is also used today for of decoration commercial places and domestic houses in the city.

Nickel (2006) proposed a new model of technology of casting of bronze vessel of Shang period in China dated to mid-second millennium BCE. Outer casting molds were decorated with fine incisions, a process that resulted in the thread-relief.

Thronton (2007) studied the different copper-zinc alloys which have been found in prehistoric contexts in Southwest Asia. He had done chronological and spatial groupings of the alloy and came to the conclusion that copper-zinc alloys occurred sporadically in this region as early as 3rd millennium BC and continued to Greco- Roman period. The alloy is rare in this region and associated with the development of other metals. There are multiple stages in the life cycle of metal artifacts from its original production, trade, secondary and tertiary manufacture, repair, reuse and recycling and finally discard.

The effort of Roberts (2008) regarding the tradition and shaping technology of earliest metal objects and metal production in Western Europe during later fourth and third millennium B. C. The author comments on the introduction of the metal technology in the area. Metal technology involves an elaborate process from the collection of raw materials to final shaping and always need expertise. Metallurgy was involved according to the perception and desire of the communities to incorporate new technology possible through the incorporation and transmission of ideas and knowledge between individuals and communities at a variety of spatio-temporal scale. The study also reveals that the influence of existing material, technological and social traditions can be seen in the subsequent selection of specific metallurgical traits by individuals and communities within the framework of social and religious beliefs and symbolism bound to the process.

Roberts, Thronton and Piggot (2009) discussed about the development of metallurgy in Eurasia. The authors gave a new model about the origin of metallurgy in the Old World. According to their study metallurgy begun in Southwest Asia in c. eleventh-ninth millennium B. C. Metallurgy was initiated with the experimentation in pyrotechnology and need for new materials for aesthetic display of identity including social, cultural or ideological. The study reveals that metallurgy was not independently invented in part of Eurasia beyond Southwest Asia and the knowledge of metallurgy

diffused across the Eurasia by the Second millennium BC. The metallurgy was emerged in America independently from Eurasia.

Amzallag (2009) postulate a new theory regarding the origin and development of metallurgy. The author tried to integrate two theories i.e. theory of diffusion and localization with the archaeological evidences and developed a new theory i.e. synthetic theory. He also differentiated crucible technology with furnace technology.

Golden (2009) gave an account on the Chalcolithic metal technology in Southern Levant. As found from archeological evidence copper was started in Iran and Anatolia during Neolithic (8000-4500 BC) and in Southern Levant it appeared in Chalcolithic period (4500-3200 BC). The metal work was done either from ingots or from smelting of metal. The complex metals with arsenic and antimony were exported in Southern Levant. No evidence of tin and zinc have been found from this region during Chalcolithic period. The tradition of complex started to decline at the end of the Chalcolithic period and at the beginning of Bronze Age it was ceased.

Hoffman and Miller (2009) discussed on production and consumption of copper based alloy in Indus Civilization. Metallurgical analysis shows that they imported copper ingots rather smelting of metals. They produce weapons, tools, vessels and ornaments. There is also an approach to study the economic and social network of Indus tradition in terms of the technology and pattern of use.

Miller (2010) studied about indigenous casting technology in South Africa. The casting technology which involves the melting of metal in a crucible and then poured into a mould was played a vital role in 2nd millennium AD for producing ingots, blanks for rings and bangles and rare ritual objects. Casting was restricted to non-ferrous metal like copper and its alloy of brass and bronze.

Higham *et al.* (2011) developed a new model of origin of Bronze Age in South East Asia. According to the model bronze metallurgy reached Southeast Asia only in the late 2nd millennium BC, through contact with the states of the Yellow and Yangtze

valleys. This model replaced the earlier model of beginning of Bronze Age about 2000 BC in the region.

Zhou in 2012 completed thesis on the distillation of zinc in China. The study highlighted the technology of large scale production of zinc in Qing Dynasties (AD 1368-1911). There is also a description of history of metallurgy of zinc and brass. The primacy of China in zinc production was highlighted in the research. There is also description of different types of brass including imported variety, cementation brass and speltering brass.

In Roberts and Thronton edited book "Archaeometallurgy in Global Perspective Methods and Syntheses" (2014) a comprehensive study was given on social and cultural context of metallurgy in archeological range of time in different geographic regions. The book highlights the Smelting processes, Slag analysis, Technical Ceramics, Archaeology of Mining and Field Survey, Ethnoarchaeology, Chemical Analysis and Provenance Studies and Conservation Studies. Beside review of earlier studies there is practical application for metallurgical techniques in the area of study.

Besides these, literatures are also reviewed on different aspects of metallurgy developed in India.

b. Studies of India:

The development of metallurgy and its present status in India have been reviewed by number of scholars from different perspectives as follows.

V. Ball (1869) probably the pioneer in the field of ancient metallurgy in India. A number of ancient copper mines were identified in Singbhum. Copper ores are found in the older crystalline rocks and in extra peninsular India these were found in metamorphic rocks. The common ores are copper sulphide, copper pyrites and Chalcopyrite. There were number of ancient copper mines and copper bearing minerals have been found from almost every states of India. Mineralogical experiments of ores of Singbhum area indicated that there is wide variety of minerals like chalcolpyrite, malanchite, azurite,

pyrrhotite, pyrite, covelite, pentlandite, magnetite, ilemenite, goethite, chrysocolla, cuprite and chalcocite. Copper was smelted from ores and supplied to the country but this began to decrease with the early European contact. The indigenous copper miners could not sustain themselves with the competition of cost of imported metal. Due to environmental degradation the mines got filled with water and became difficult for miners to get inside the mines.

V. Ball (1888) wrote an article on brass casting in India. He gave a description and characteristics of different metals including copper and zinc. Zinc was mined from Jawar in Rajputana and it was closed in 1812. Tin was not available in India, the source was in Burmah. He is also of the opinion that true bronze was not manufactured in India. Compounds of zinc and copper were widely used in India for manufacturing of domestic utensils and ornaments. These metals were also imported because local production was not sufficient. The metals were melted in rudely made furnace adjacent to brass founder's house. They practiced casting in mould. The lost wax process of hollow casting was practiced and was indigenous in origin.

A monograph "Copper in Ancient India" was written by Neogi (1918). The study was based on literary sources.

After a long gap Gordon's paper titled "Early use of metals in India and Pakistan" was published. Probably it was the earliest work on Indian metallurgy published in 1950. According to him copper based technology developed in three phases. The Amri culture had contact with Iran. He proposed that Harappan people came from Mesopotamia and post Harappans brought copper hoards in the Ganga valley.

In Baldev Raj edited "Brass and Copper Artwares of Delhi" K. C. Nautiyal (1964) gave a vivid picture about the brass craft and craftsmen. This study was done as a part of survey of handicrafts and household industries, Census of India 1961. The study deals with the history, location and institution of the craft, concentration of production units, about the craftsmen and their nature of employment. Different types of finished items, designs, traditional and modern designs were analyzed with photographs. Different aspect

of technology regarding raw materials, tools and appliances, stages of production techniques were described with the structure, organization and institution of the craft. Suggestive measures also have been given in conclusion about the revival and reorientation of the craft.

K. T. M. Hegde's (1964) work on copper objects from post Harappan Chalcolithic period shows that during the Ahar culture the copper ore from Khetri region was utilized.

C. C. Lamberg-Karlovsky (1967) is of opinion that copper ores of Pre Harappa, Harappa and Post Harappan times were traded from Afghanistan, Pakistan and Oman.

A series of research articles of D. P. Agrawal were published during 1968 to 1971. He is of opinion that Harapaan people used copper from Rajasthan mines and the concentration of tin in some bronzes were not deliberately alloyed because of there is scarcity of tin. He is also opinion that arsenic was used deliberately to make an alloy. The metallurgical tradition of Harappa had some affinities with Southeast Asia. The differences of technology and alloying pattern of pre Harappan, Harappan and post Harappan and Gangetic copper Hoard was due to different technological groups in different geophysical settings.

H. C. Bharadwaj (1970) made a comment that alloying pattern and technology of Harappa was different from Western Asia, Egypt and Mesopotamia. On the other hand there were regional variations in technology between Harappan metallurgy and Gangetic valley Copper Hoards culture.

Agrawal and Guzder (1971) are of opinion that Harappan metal tradition did not come from a single direction. The tradition of Northwest India came from Western Asia, whereas the metallurgy of central, western and Deccan were probably indigenous in nature.

A review work of Ancient Indian technology and production was presented by Ray and Chakrabarti (1975). They reviewed a series of works based on archeological and literary data of copper, bronze and iron.

Mukherjee (1978) carried out an extensive study on metal craftsmen of different parts of India excluding Assam, Gujrat and Maharashtra. Copper, brass and bell metal craft and artisans attached with the craft have been taken into account. Emphasis was given on caste affinities, hierarchical position of the craftsmen, different aspects of metal technology and its variation in different states of India. The diagrams of different stages of technology and finished products are vividly presented. She classified the metal artefacts into four categories- household utensils, sacred vessels, icons, ornaments and art ware. Copper is considered as sacred metal. Artisans are known as Tamotas or Tamtas in sub-Himalayan region; Tamrakars in Nepal, Tamera in Uttar Pradesh, Madhya Pradesh, Orissa and Bihar, Viswakarma or Vishwabrahmana in southern states and Ragi in Andhra Pradesh. Copper traders of West Bengal are known as Tamrabaniks. The artisans who work with copper alloys belong to warrior (Kshatriyas) castes. The casts are known as Kaser in Patna and Bihar, Kasera in North-west and Thatera in the North. In Moradabad most of the artisans belong to Muslim community. In Bengal the metalcrafts men are known as Kangsabanik. There are number of sub castes like Saptagrami, Mahmudpuria, Mahita, Andure. Karmakar are important caste group of Bishnupur and Kansaris are widely distributed in Orissa. Beside these there are also folk metal artisans who practice lost wax process of metal casting distributed in Orissa, West Bengal, Madhya Pradesh, Andhra and Tamilnadu.

Bharadwaj (1979) reviewed on the copper metallurgy in Ancient India extensively. According to the study the sources of copper during Harappan and Chalcolithic period was Khetri belt of Rajasthan and new mining areas discovered during the Copper Hoard culture was Singbhum copper belt of Bihar. The metal technology was rejuvenated with the discovery of new mining area of Singbhum.

Soundara Rajan, K. V. (1982) gave a detail account of metal tools in protohistoric India.

Tiagi and Aery (1982) surveyed about the plant species which are common in zinc deposition area in Zawar mines in Udaipur, Rajasthan. The study reveals that

Impatiens balsamina is the most characteristic species on metal dumps. They have also opinion that it can be considered as a local indicator for the metal zinc.

Willies et al. (1984) had given a detailed report about two lead and zinc mines in Rajasthan i.e. Zawar and Rajpura-Dariba. The archaeological evidence shows that zinc was regularly mined in these two mines from the Medieval period and also continued to modern times.

Ahmed (1991) vividly described the metal craft of Bangladesh. The archaeological evidences are yielded from Mahasthangarh, Moinamoti, Paharpur. Though the sculptures are seems to be made of bronze, but the author opined that due to lack of metallurgical analysis the contents of the artefacts are not clear and both brass and bronze were used to make these objects. The artisans were known as Kansari, Bidrisaj, Cherakosh. At the end of the British period ritual and household objects were made and decorative items were imported from the West. The raw materials used for the craft are local and sometimes new brass was imported from Korea, Japan and China. Venders collected scrap metal and artisans got the same from middle men. There are factories for melting of scraps in Tejgaon, Nol gola, Mirpur. Different technology of metal work was practiced i.e. casting, moulding, sheet work, finishing and designing. Different types of designs include engraving, repousses, inlay, mina kari etc. Colouring was done by mixing of different chemicals. Cire-perdue technique was used to make hollow dolls. A detail description including sources of raw materials, technology, finished objects, production cost, profit, income are described taking into account the problems, difficulties and chance of survival of the craft in modern times.

Chakraborty and Bari (1991) gave a detail account of handicrafts of West Bengal including brass and bell metal craft. According to their opinion copper is the earliest metal used by man. Household utensils of brass and bell metal craft of Ghatal and Chandanpur in Midnapur, Tikarbeta and Lokpur in Birbhum, English Bazar in Malda are described together with indigenous dokra craft of Bankura, Burdwan and Midnapur district of West Bengal.

A preliminary study was done by Seshadri (1992) on composition and techniques of copper artifacts from Nagwada, a mature Harappan site in North Gujarat. Chemical analysis reveals that the axes found from the site was made from pure copper with significant quantity of arsenic. The impurities like cadmium, nickel, zinc, magnesium, cobalt came from the impurities of the ores. The composition of Chisel found indicates that the alloy is bronze. The technology was casting in well-ventilated mould. The experiment was done on two objects which may act as a representative of the metal technology of Harappa.

Biswas (1993) proved with the archeological and literary evidences that India stands the first in zinc and brass metallurgy. The brass contains high percentage of zinc, which became possible after the introduction of distillation of metallic zinc. The distillation process of zinc was introduced in Zawar area of Western India and was transferred to Bristol in England before 1730. This tradition benefited the growth of Greek, Arab and medieval European sciences.

Sarkar (1994) gave a historical overview about the impact of changes of role of the market and technology on the social organization of artisans in 18^{th} and 20^{th} Century in India. The study was done on the Kansari, a metal working caste. The author vividly described the mobility of the caste group and their changing status with the demand of the society and the decreasing of their social position with the competition of the cheaper materials. The study also highlighted the different factors which effect on the social position of the caste system in the society.

Deshpande (1996) described the zinc smelting in India and China. He opined that the metallurgy of zinc developed much earlier in India and China than in Europe. He supported his study with textual records and systematic investigation of ancient relics of zinc as a composition of brass. This study highlights that zinc was smelted three centuries earlier in India than China and the idea was transmitted by the sixteenth century AD to China.

A study of market and artisans related to brass ware during colonial period in India by Roy (1996) was an approach to know the reason behind the survival of the craft for a long time and how it coped up with the commercialization and market development. The craft is continuing due to making of utilitarian objects. Some rituals and symbolic aspects are also related to the craft. The industry did not modify so much during the period in exception of the development of some small factories and use of imported brass sheet. This was the scenario of markets of nearby towns or cities, but in rural areas the craft continued with its artisanal features to fulfill the local needs and demand of the people.

Kenoyer and Miller (1999) made a meticulous study of metal technologies of the Indus Valley in Pakistan and Western India. A number of evidences including crucibles, kilns, slags discovered from different sites of Indus Valley civilization were analyzed in order to reconstruct the Harappan metal technology. The potential sources of Harappan metal ores are discussed. The sources of copper are Oman, Rajasthan and Afghanistan-Baluchistan. Zinc was found as impurities in copper ore (0.18%). Different stages of fabrication of metal objects were shaping, cutting, joining and finishing. They also practiced casting technology. Metal was used to produce utensils, ornaments, tools and figurines. In few objects zinc was found in traces sometimes in quantity greater than 1%. Copper and Bronze was extensively used, but brass and zinc was absent in Harappan metallurgy.

Srivastava (1999) described different furnaces for smelting different metals in Ancient India. The main emphasis is given on Copper, zinc and iron smelting furnaces together with gold and silver. The work was done in combination with archeological evidences and ethno-archeological data. Copper smelting furnaces found from Lothal are of two types rectangular and circular. The ancient copper smelting furnace found from Aravalli hills has similarities with present day copper smelting furnaces. Zinc smelting furnaces were studied on the basis of archeological evidences found from Zawar mines. The furnaces prove the process of distillation zinc from zinc ores.

Chattopadhyay (2000) gave an account of stylistic variation of metal statues and figurines through ages in India. The concept of alloy like brass and bronze was found in Matsyapurana, one of the ancient epics. The evidence of dancing girl found from Mohenjodaro dated to 3rd Millennium BCE was produced by lost wax process of metal casting. Large-sized image casting was found during Gupta period (4th Century A.D. to 750 A.D.). The dominant raw material was bronze with various other metals like astadhatu, an amalgam of eight metals, panchaloha, a combination of five metals, were also used to make the images which signify the cosmic relationship. In Bengal the Pala kings patronized casting of metals and stele image, which were characteristic features influencing bronze sculptures in Nepal, Tibet, Burma and Thailand. Bronze images of the South during Gupta period emphasize excellent craftsmanship in metal casting. During Chalukyan and Rashtrakuta patronage the craft reached to its high artistic and technical perfection. In Pallava Dynasty the metalwork was ornamented with sensitive motifs. New aesthetic dimension was carried out during Chola period such as Deepalakshmi, a ritual object. The tradition was continued in the Vijayanagar style with sharp lines, prominent eye and slightly grooved face. The status and position of Sutradhar and Stapathi also have been written as super master-craftsmen.

Hacker (2000) gave an account of the brass craft of Bastar district of Madhyapradesh. The brass craft made by lost wax process is practiced by indigenous communities in Baster through the generations. The study unfolds a number of events regarding transformations of indigenous objects initially of ritual significance into objects of commercial value and the role of expanding markets on the present economics of crafts and to the changing roles that tradition, innovation, and ideology engage in recreation in their production.

Balasubramaniam *et al.* (2001) studied metallurgical aspects of copper hoard of OCP period. The study was done on the findings of 31 anthropomorphic figures of copper from agricultural field of Madarpur village of Moradabd district in Uttar Pradesh. The microstructural analysis shows that the composition of the metal was pure with negligible impurities. The presence of lead (Pb) indicates that copper was extracted from

sulphide ore. Micro hardness measurements proved that these were made by casting process.

Brass and zinc metallurgy in pre-Modern India was reviewed by Biswas (2001). There is an observable difference between brass before and after discovery of zinc. The proportion of zinc in brass varies in former types, probably made by cementation process and in later types the proportion of zinc is more than 28%, which is possible after the extraction of zinc from zinc ore. According to the author the high percentage of zinc was made after the isolation of pure zinc metal. Emphasis was given on mining archaeology and smelting technology of zinc ore in India. The underground mining in India dated to thirteenth century BCE. The important mining centers are Rajpura-Dariba, Zawar Mala and Rampura Agucha in Rajasthan. There are evidences of Roasting and distillation method of zinc. The evolution of technology of zinc smelting from Ancient to Medieval was analyzed with the help of literary sources. The result shows that the primacy of India on brass and zinc metallurgy is not disputable and the tradition migrated towards the West. There is also a description of indigenous technology of chemical hypotheses, history of Bidri art, which contains 76 to 95% of zinc.

State-wise distribution of different crafts of India was given by Bhattacharya and Chakrabarti (2002). The craftsmen belonging to general communities practice brass metal craft in Gujarat, Jammu & Kashmir, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Tamil Nadu and West Bengal. Scheduled caste community of Uttar Pradesh practices the craft. The scheduled tribe community of Madhya Pradesh practices the craft.

Dhamija (2005) in his book “Indian Folk Arts and Crafts” highlighted on metal ware including brass, bell metal and bronze objects. He has given a variation of metal objects in different parts of the country with emphasis on both folk metal craft and modern technology. The differences between ritual objects and household utensils in terms of technology, decoration and form of raw materials used are described in the study. There is description of casting, sheet metal work and *cire perdue* technology. The religious beliefs and practices associated with these metal wares also have been highlighted. Metal was considered as sacred and thus special objects were made. Most of

the forms have been derived from clay vessels. The designs or engravings are done on objects used for decorative purpose or ritual purpose and the designs symbolize different beliefs and mythology.

Kharawal and Gurjar (2006) made a comprehensive study on zinc and brass in Archeological perspective in India. The study reveals that the evidence of pure zinc comes from Zawar as early as 9th Century AD. They opined that distillation of zinc was first invented in India on commercial scale around 12th century and in China it was started almost three hundred years later than India. Indian zinc reached Europe earlier than that of China. The study was supported with the evidences of archaeological remains and radio-Carbon dating of ancient zinc smelting in Zawar area in Rajasthan.

A description of copper craft in Almora, a newly formed state of Uttara Khand is given by Basu and Prasad (2009). The craftsmen are known as Tamta and considered as indigenous inhabitants of this region. They are placed in the lowest rank in the category of Dom. In 1815 the copper mines in the area were closed down and the craftsmen depended on local businessmen known as *Lala*s who imported raw materials of the craft and supplied to the craftsmen to make copper utensils which had demand in neighboring areas. The artisans became wage labour and at present most of them do not claim to pursue the craft because of hard labour for twelve hours a day in exchange of minimum wage, unhygienic condition of workshop and work opportunity for six to seven months in a year. They also do not encourage next generation to continue the craft.

Gullapalli (2009) gave an account on early metals in South India megaliths. There is prevalence of copper in Neolithic period in South India. The use of copper gradually decreased during Megalithic period. Iron was dominant over copper artifacts in megalithic context of South India.

Grover (2014) made an attempt to explore correlation between folktales and ancient mining activities in Rajasthan and Gujarat. The folktales of nearby area combined with geological condition help to understand the ancient mining activities of the area. The

study includes not only copper, but gold, silver and iron also. These folk tales are the clues for archeologists to find out the ancient sites where mining activities were done.

c. Studies of eastern India:

The development of metallurgy particularly in the eastern part of India has been studied by a number of scholars from different disciplines.

Sahoo in 1982 had done an anthropological study of the Kansari of Orissa with emphasis on different aspects of ecology, economy and technology. It was noticed that there are two types of metal working communities in Odisha- metal artisan and folk metal artisan. The folk metal artisans practice lost wax process, whereas the other group of artisans practice metal craft different copper and copper alloy. The folk metal artisans live in rural setting and other metal artisans concentrate in urban set up. Folk metal artisans serve peasants and the tribals, whereas Kansari serve the mainstream people of Odisha. There is also an attempt to study the variation of social structure, social institutions and technology of production between these two major categories of artisans.

Mohanti had done an extensive ethnographic study on metal artisans of Odisha since 1982. The author (1975-1987) gave an account on the social identity of Kansari. The interest of social identity in a particular structure, role of performance of identity, inclusion or exclusion of persons in the identity category and ideological ground were highlighted in case of Kansari caste of Odisha. An ethnographic study of folk metal artisan, Ghantra of Orissa was done by Mohanti in the year 1983. A socio-economic and cultural milieu of Ghantra was explored in one village of Ganjam district of Odisha. There is also an attempt to describe the social structure and hierarchical position, social control, religious beliefs and rituals, life style, economy of Ghantra in the particular geophysical setting. Different aspects of technology of lost wax process including raw materials, tools and equipment, technique of manufacture and finished products was highlighted with different diagrams. There is also an attempt was taken by Mohanti (1986) about the struggle and survival of the Orissan Craftsmen. It is a comparative study of crafts based castes of Odisha including metal craftsmen. The process of survival of the

craft with rapid economic development and modernization during the post-independence period in India has been depicted in the study. In 1990 the author gave a detail account of ritual use of areca nut among the Kansari caste of Odisha. There is a ritual of giving different types and number of areca nuts to caste councils of Kansari both by the bride and groom at the time of marriage ceremony. The ritual within a society stands for the promotion of reciprocity within the community. According to him, "It is an institutionalized form of extra-economic transaction and it presupposes multiple symmetry in the contextual framework of the caste system".

Mohanti (1993) had given detail ethnography with special emphasis on caste-cluster, caste identity, social mobility of Kansari, an artisan caste of Orissa in India. They are endogamous groups and follow Hinduism. The hierarchical position of Kansari is middle-range. The study reveals the social process concerning social solidarity and mobility of the caste, social institution, structure and function of caste council and different social and economic constrains of solidarity. They engaged in copper, brass and bell metal work. Bell metal and brass utensils are produced by heating, beating and shaping. Sheet metal work is found in South Odisha whereas the other parts are engaged in wrought metal work. The production unit is basically household industry and a number of indigenous tools are used in manufacturing process. They maintain craft secrecy and social network among, workers, traders and financers to run the business.

Sarkar (1994) wrote an account on the history of the Kansari movement in Bengal. The study highlighted on of changing condition of the social rank of the caste determined by the ups and downs of the industry. There is also a description of caste solidarity and caste mobility in different socio economic and political scenario. As a migratory in nature metal craft was developed in western part of the state, which is known as *Rarh*. At the beginning of the nineteenth century Kansaris achieved the higher position and throughout the nineteenth century and early twentieth century the industry had a significant growth and the position became reversal with the diffusion of the cheaper wares throughout the province.

Lahiri (1995) gave an ethnographic perspective of metal related artifacts as cultural signifiers. Archeological records in early India suggest that copper was used for ritual objects. The metal tradition of India is characterized by recycling of metal and scrap mold metals. Scrap metals used to make new objects as well as selling in large brass manufacturing centers. Sometimes it can better be understood in a symbolic sense, as signifiers of social and cultural beliefs. The author told that brass was considered as waste materials and high caste, followers of the god Vishnu do not use brass. Among the Ao Naga broken and unserviceable brass was used to make bracelets.

Ray *et al.* (1997) made a study on brass working communities in Pallahara region of Angul district of Odisha. The approach was anthropo-archeological study of brass metallurgy in the area. There is a description of an indigenous metal smith community Sidhria in the light of archeological evidence of the brass in the area. They practice cire-Perdue method (lost wax) of brass casting through the generations. Detail description was given of technology including raw materials, tools and implements, methods of manufacture, types of objects made, marketing and religious aspects associated with the craft. There is an attempt to reconstruction of brass technology by means of parallel which may through light in the understanding of prehistoric brass working in the area.

Kumari (2002) examined the present status of brass craft of Malhar of Ranchi district of Jharkhand as a vanishing art. Beside technological aspects the study also highlights the problems of survivality of the craft and craftsmen. 90% of them have been taken up metal repairing and wage labour for their subsistence. Though there are number of attempts have been taken by the Government but the limitations are that the entire process is time consuming and techniques are very indigenous in nature. The craft shows the nature man relationship and is continuing by maintain a symbiotic relationship between rural folk mostly peasant and artisan communities.

Chakrabarty (2009) contributed a detail account of Dokra craft of West Bengal in the light of legacy of Indian archaeometallurgy. The lost-wax process of metal casting is still surviving among the indigenous communities in different parts of India like Orissa, Bihar, Madhya Pradesh and Maharashtra. The study pointed out the techno-economic

aspects of Dokra craft highlighting the variations of technology and types of items produced. The craft is migratory in nature and presently distributed in Bankura, Burdwan and West Midnapur in West Bengal. The author divided the technology into three stages- pre-designing Stage, designing and covering up stage, casting stage and post casting and finishing stage. The study reveals that women folk are engaged in clay work, firing and cleansing whereas male folk engaged in procurement of raw metals, preparation of mould, wax modelling, firing, casting and marketing. The finished products were divided into religious items, objects of utility and decorative items and ornaments.

Chattopadhyay and Sengupta (2011) made an attempt to study the metallurgical tradition of Eastern India and Bangladesh. The origin and development of metallurgy in this area have been analyzed with historical background and archeological culture. Detail description of sources of ore, process of extraction, and manufacturing technique of different metals like copper, iron, gold, silver have been given. Alloys of copper including bronze, gun metal and brass have been given a special emphasis with present day indigenous method of making and working with alloy. The main observation regarding the brass is that the source of tin is scanty in the studied area. Brass was used for manufacturing of household utensils and ritual objects. Authors also comment that the supply of zinc also was not adequate in the area. First they learnt the technology of alloying with small amount of tin, then high percentage of tin and gradually developed into gunmetal.

Mondal (2012-2013) studied in detail the lost wax process of metal casting practiced by Ghantara, a scheduled caste group of Dhenkanal district of Odisha. There is also an attempt on reconstruction of technology of brass work, which was found in archeological context in the Chalcolithic deposits in Odisha. The form and designs have similarities, which help to understand the past technology. It is very interesting that the geophysical settings have similarities with the Chalcolithic settings. The craft is closely related with the natural resources, so it is very much indigenous in nature. The community in the area maintain a symbiotic relationship with the others communities in the village to continue their craft, on the other way they maintain craft solidarity by

practicing marriages within the community. There is also a description of technological aspects from collection of raw materials to the marketing of the craft including procurement of raw materials, preparation of mould, designing of wax, casting and finishing. They also depend upon middle man for supply of raw material of the craft and also marketing of the finished products.

A monograph on Dhokra art of West Bengal was written by Jana (2013) based on supportive data from archaeological and literary sources as well as field survey in Bankura and Burdwan district of West Bengal. The study highlights the different aspects of lost wax casting tradition in India, origin of Dhokra artisan, preparation and art objects.

In most of these studies emphasis is given on metal technology and a little on metal artisans. The above discussion led to the conclusion that study of contemporary technology is an essential part of the reconstruction of metal technology of prehistoric and protohistoric period, if the traditions are culturally linked. The sources of raw materials, shape, decoration and chemical properties are important clue to the study of diffusion, exchange and trade. Most of the scholars wrote about the mode of reconstruction of metal technology but few works are oriented on understanding of the metal artisans. The resent study has not only paid attention to the brass technology in the selected areas, but also paid some attention to the organization pattern of the society they lived and their relation to the others inhabiting in the area. They have symbiotic relationship with the other groups residing in the areas. As far the literature surveyed there is no work conducted by anthropologists particularly on the brass work and the artisans in the studied area i.e. the eastern part of India.

1.5 Relevance of the present study:

Metallurgy is an important invention of human history. Out of the different metals used by the early people brass perhaps the earliest alloy which was developed in the eastern part of India. It was the most important and widely used alloy as evidenced from

the archeological record and has a long history in the region. It is clear from the above literatures that except a very few exceptions the in depth study on brass working communities are not considered under the purview of Archaeometallurgy in India in general and eastern India in particular. The present work not only highlights the different communities who engaged in brass work in different geo-physical settings of the studied area, but also on the emergence and development from its prehistoric origin. Emphasis was given on indigenous technology with an aim to reconstruct the brass technology of the past. The present study is important from anthropological point of view to know the socio economic condition of the people in which the craft is continuing and the changes in technology through time to reconstruct the evolution and variation of the brass technology from prehistoric period as well as past life ways of the people associated with this technology.

The above discussion led to the conclusion that study of contemporary brass craft is an essential part for the reconstruction of the technology of the past, especially if the traditions are culturally linked. The tradition of common shape and sizes has functional implication as well as decorations and designs give important clue to the study of diffusion, exchange and trade. The present study not only emphasized on brass technology in the selected areas but also paid attention to the organization pattern of the society in which the craftsmen live and their relation with the other communities live in the areas.

1.6 Research methodology:

Methodology is built up in accordance with the problem. It involves a number of activities starting from library work to sample survey (Goode and Hatt 1952). It starts with formulating of research problem, conceptualizing the research design, selection of sample, methods of data collection, processing of data and writing of report (Kothari 2004).

The focus of the present problem is on brass. It starts with the beginning of brass in the region in terms of chronology. The framework is quite broad which includes the basic technology of making brass objects as well as the people associated with the technology. It is important in the sense that brass technology needs a good deal of skill, knowledge and precision.

Brass objects in the present time include a number of varieties bearing with the functional aspect. There are significant changes in shape and size with time, which is again related to functional connotation and their use. Variation is also correlated with spatial differences and also is modified by traditional value system of the people using the brass objects. These are of great significance. Attempts have been made to find out the changes and to identify factors behind these changes.

Emergence of metallurgy is the precursor of many new traditions in the cultural perspective. New technology gave rise to a number of developing attributes, which are in integration may be termed as the full development towards progressive direction. In the course of change, some traits became marginalized and new traits appeared. On the whole the present study is a cross-section of brass objects and the artisans associated with the craft, with special emphasis on change through time.

A number of communities in Eastern India practice both indigenous and modern methods of brass technology. Adequate data are available on the present day brass working people for fulfilling the objectives of the research but the data from the archeological context is not adequate. Time, money and people are also important resources of a research project. For the present study maximum time was spent for the fieldwork and rest for discussion with supervisors, analysis of data and writing of report. The project was partially funded by UGC and rest expenditure has been borne by the researcher.

Data is collected from both Primary and Secondary sources. Primary sources are existing literature and documents. The resources of documents of literature are three: people, review articles and bibliographies, online database. For the present study all of

the resources were utilized. The people who are expert and also interested in the topic were interacted with. Different sources of literature by email, phone, academic discussion and also through face to face contact were used for the study. Annual Review series of many disciplines have been surveyed to know the trend of present study. Bibliographic search include journals, books, reports of Government, industry and private research foundation available both online and as printed products.

Verbal consents about their willingness to participate in the study were obtained from all adult individuals prior to the actual commencement of the study. Parents of the studied children were also asked to give consent before collecting information along with his/her willingness to participate. Name of the informants are not disclosed in the report.

Variables taken for the study are of two types qualitative and quantitative (Bernard 2006). Qualitative data is also quantified according to the objective of the study. Both qualitative and quantitative data are analysed through relevant statistical methods in the study.

1.6.1 Sample size:

Primary data for the present study were collected from four clusters (Berhampore, Shibalaya, Bishnupur, Bikna Shilpadanga) of West Bengal and two clusters (Rathijemapatna and Sadeibereni) of Odisha. State wise distribution of total families and individuals are presented in the followings:

Table 1: State-wise distribution of population sample

States	Families	Individuals
West Bengal	556	2628
Odisha	493	2631
Total	**1049**	**5259**

1.6.2 Selection of clusters, households and individuals:

Eastern India was selected because of a number of communities practice brass work in traditional way here. Emphasis was given on West Bengal and Odisha. The clusters were selected on the basis of the concentration of artisans who are traditionally engaged with the brass work. Different clusters are selected because of the artisans of each cluster practice different technology of making brass objects. Each cluster is located in different geo-physical set up. Geo-physical set up of a particular area is also responsible for development of craft, because raw materials necessary for the craft are collected from surrounding area. The artisans of each cluster belong to different communities, though they are related to the brass work as their hereditary occupation.

1.6.3 Nature of data and method of data collection:

As the basic objective of the present study is a socio-economic condition of brass artisans and technology of making brass objects data from each village or township is collected with exact geographical and political location in relation to the nearest town, block office, post office and police station. Communication facilities in terms of roads and railway are noted. Communication is very important aspect for bringing the raw materials and for delivery of the finished objects to the consumers. Elevation from the sea level help to understand the sources of raw materials and location of forest for collection of fuel are also noted. In addition to the communication facilities modern amenities, like drinking water, educational institutions, hospitals and health centers, markets both wholesale and retail are noted.

Brass artisans live in multiethnic village or township. They serve different communities with their craft and also depended on them for subsistence. Demographic composition of the areas under study is important for understanding this relationship. Census was taken from community level. This begins with the different communities living in the villages or townships. Household survey is done in the next phase. Schedules are prepared for each artisan family surveyed. Information is collected from individuals

in a family. For each family name of the members, age, sex, relationship with the head, education qualification, and marital status, place of birth, occupation and income are taken into account. Data was cross checked from several sources. Data was also collected from each family. Informal discussions and observations were also made to get information about opinion, experience, situations, problems and prospects.

Education qualification is an important factor of socio-economic aspects of the artisans. Education is closely related with the occupation. Occupational status of each individual both male and females, part time or full time are noted. Income is closely linked with occupation. Brass working is considered as full time occupation. It is also necessary to know the duration of work per day in order to understand these facts. The reasons behind giving up of brass work and shifting to other occupation have been taken with a view to understand the occupational mobility.

Technology of making brass objects is quite traditional in nature. Data on technology, starts with raw materials, their sources, tools and equipments used for making brass objects, mode of casting, shaping, finishing and finally marketing. The sources of raw materials distance of the sources from the village or township and the mode of procurement are studied. A threshold model is built up. Usually they live close to the sources of raw material like clay, wax, fuel and convenient mode of transportation. In case of towns the artisans live near the market area for easy availability of raw materials. For this both direct observation as well as interview methods were followed.

Tools used in making brass objects are studied in detail. Hammers, stakes, anvils, and other equipments used in the craft are studied on the basis of shape, size, material used, cost and source. Household survey is made on the implements they used in their workshop. Similarities and variation in the raw materials, tool types, firing and manufacturing of brass objects have also been taken in consideration. This also depended on the geophysical setting of the studied area. These variations are linked with the different groups of brass working communities. Role of women in brass technology also varies from one group to the other. There is an attempt to link the variation with social phenomenon.

Furnace and technology of firing are studied by direct observation method. In case of lost wax process several families jointly fire their mould. Furnace type varies from one place to another. Furnaces are located in their workshop and position of the furnace in relation to the wind direction is noted. The process of firing was observed from starting to finish.

Skill is important in the study of brass craft. Manufacturing of brass objects needs special skill in casting, shaping and finishing into final form. All these stages need special knowledge and skill. It takes long time to become master craftsmen. They started the job in their early age as an apprentice and in old age skill deteriorates. This kind of study is done with direct observation and interview methods. Data was also taken about age for beginning of work and retirement. In old age they perform less laborious work such as controlling the bellow, finishing of moulds and application of soldering materials for welding. Division of labour in terms of sex and age groups also has been taken into account by observation, schedule and interview methods. Artisans are also able to identify their products according to the shape and finishing. In some cases artisans put their mark of individual at the bottom of the objects they made.

Artisans suffering from unwillingness and ill health in relation to the craft were contacted with direct observation and interview with the sufferers.

Objects manufactured in different areas have been described according to their shape, size and form. These also are of different types depending upon use and functions, such as, domestic utensils, ritual objects and decorative items. The objects also are classified according to their function. Objects manufactured in each workshop is noted and measured. Designs and decorations are studied with their sources and norms and beliefs associated with the designs and patterns. Classification is made on the basis of shape, size and function. Interview method and observation helped to know these hidden aspects of technology. Information about the present day use of these objects has also been studied.

Metal pots are replaced by different cheaper materials. Despite this metal pots are still preferred for a number of reasons. Factors responsible are reselling value, strength, diversity in shapes and sizes and beliefs such as the concept of purity and hygiene. This is also studied by interviewing not only the artisans but also the people who use them in the surrounding area.

Demand is directly related to production. Mode of marketing and distribution is also related with the production. This is studied by visiting the markets and fairs where artisans sell their products. Interview also was taken from traders and middle men regarding the demand of the different objects. Artisans also were interviewed regarding the process of marketing and markets they prefer. There are two kind of markets, wholesale and retail. Wholesale market involves middle men who buy the objects in bulk from the artisans. They take the responsibility for selling these objects and artisans only get the wage per object.

Retail market is absent in most of the cases because there is no option for direct selling. Few artisans have shops as their own; rest has to depend on traders and middlemen. These data were collected by direct observation and interview with the artisans and shopkeepers of the nearby markets. Threshold model (Arnold 1985) also is made on the distance of market from the villages or towns. In case of town markets are close by, but in rural areas markets are far from the villages. Overlapping of different objects in the market also noted.

Demand and supply is also closely linked with the economy of the artisans. Brass workers are in the process of giving up their traditional occupation and taking up other types of occupation of higher pay. Analysis also has done about the type of occupations. These are categorized onto three types i.e. artisans who are solely involved in brass working, artisans who have other occupation in addition to brass working, people who have completely given up the brass working.

Data on earnings were converted to per capita income of the families. This is also classified according to the categories like families who solely depended on brass

working; those who combine brass work with other occupation and those who have totally shifted to other occupation. Income of those families who involved in new occupation giving up their traditional occupation is noted. Analysis also has been done on the education qualification of the individuals for comparing the changes that had taken place due to higher educational qualification. At present in most of the cases artisans got only the wage. In case of lost wax process they can sell their product to the Government as well as through the co-operatives. Different Governments documents regarding this information also were surveyed.

Finally factors of changes of occupation and diversification of the crafts have been taken into account. Changes are closely linked with economic aspects. Changes also evaluated by studying the artisans' attitude and opinions. For this study interview was taken from the artisans.

There is also an attempt to reconstruct the past technology with the help of present day brass workers. Again these are also helpful to understand the evolution, change and modification of the craft through time.

1.6.4 Procedure for analysis:

Data collected were analyzed for getting the result. Analysis is done on the basis of description and categorization. Frequency of different category is shown in tabular form as well as pictorial representation. Age groups are classified with 10 years interval to show the category from which the labour force comes. Sex ratio (No. of females per 1000 males) of each community also are calculated to show the progression or stability of population. The present study is not entirely free from estimation and /or approximation in determining age. However, age was estimated through the official records or birth certificates. Literate and illiterate have been measured as per rule of Census of India. Those individuals who could read and write their native language were considered as literate and those couldn't as illiterate. Types of occupation were considered as per maximum duration of involvement in a kind of job among adults of the habitats. Per

capita income of the population has been calculated based on the following indices (Directorate of School Education. 2015):

Per capita income = Total family income (monthly/annually) / total number of member in a family

Dependency ratio also is calculated to see the involvement of the child into the craft. It is calculated by the percentage of children (aged under 15 years), and the older population (aged 65+), dividing that percentage by the working-age population (aged 15-64 years), multiplying that percentage by 100 so the ratio is expressed as the number of 'dependents' per 100 people aged (Rao 1996).

Dependency ratio = (Percentage of children aged under 15 + Percentage of older population aged 65+) 100/ Percentage by the working-age population aged 15-64 years.

Descriptive analysis was done for the socio-economic parameters. All the analysis was done using SPSS 16.0 (Statistical Package for the Social Sciences) software.

1.7 Writing of report:

After field work and analysis of data the report is written in the form of a thesis. Report is divided into six chapters. List of tables, figures and maps are before the starting of the main chapters. The first chapter is introduction. There is an introduction about the work, background of the research, objectives, review of existing literatures and relevance of the present study. The second chapter deals with the archeological evidences of copper, brass and bronze from sites around the world with focus on India in general and Eastern India in particular. There is also description of the ancient technology of brass and the primacy of Eastern India about the production of brass. Not only brass, there is also description of mining and production of zinc from ores in an indigenous way. Chapter three is of the area of study. There is a description of the village or town under the administrative areas and also geo physical settings of the area which is associated

with different aspects of technology. A socio-economic profile of the studied community also is highlighted in the chapter four. Fifth chapter is of contemporary technology of brass in different parts of West Bengal and Odisha. Result and discussion is written in subsequent chapters of six. References and photographic plates are given after the end of the chapters. The report is written in own language as far as possible and self opinion. There is also an effort to minimize the biasness, though limitations have not been ignored.

CHAPTER II

2. EVIDENCE OF COPPER, BRASS AND BRONZE IN THE WORLD WITH FOCUS ON INDIA

The focus of the present study is on brass. However evidences of copper and bronze of the past are studied as related metals. There is a close link between the emergence and evolution of metals like copper and bronze with brass. Technology of making copper and bronze objects sometimes has similarities with brass technology. Analyses of bronze or brass help to identify scarcity and supply of raw materials for making these alloys in different regions of the world. Evidence of bronze as well as tin is also important to test the hypotheses of primacy of brass in eastern part of India. On the other hand these evidences indicate ancient metal trade.

Before going to the details about antiquity of copper and brass, it is necessary to understand the terminologies related to metal using cultural stages. Otherwise it would not be possible to fit these periods in a proper chronological framework. However terminologies, chronology and dimensions of these periods vary in different regions on the basis of material remains found and concepts being changed through time with new discoveries.

2.1 Periodization of metal using cultures:

Early Greek philosophers divided the history of mankind into four Metal Ages, namely Golden, Silver, Bronze and Iron. This division was discarded gradually and another series such as, Copper Age, Bronze Age and Iron Age was developed on the basis of evidences found in European prehistory and Near East. The copper metallurgy probably diffused from Southwest Asia into Europe and other parts. The “Copper Age” is

also covered by the term “native metal age”. This was the first step on the path of development of metallurgy. Metal produced in the beginning were still few and their influence on human society was still small. According to Stern (1969) copper-using stage was rather short in the Middle East and Europe. Bronze work was developed soon and continued in full-fledged form. Copper work was well-developed in North America, where native copper was available. Rich copper ores and native copper was common in occurrence in the Middle East, Egypt and Europe but there is scarcity of tin. Stone implements therefore continued for a long time perhaps because of the scarcity of tempering materials like tin and zinc as well as lack of alloy making skill. Bronze Age is also absent in other parts of the world. American Indians learnt smelting, casting and alloying later and continued to hammer out the objects for thousands of years.

The terminology Metal age, Copper Age and Chalcolithic stages are more or less similar and sometimes create confusion for the researchers. According to Forbes (1950) “*Copper Age* or *Chalcolithic* is often used to denote the period between Neolithic Age and the “advent of Bronze”, or if a true Neolithic is absent, the gap between Mesolithic and the “Bronze Age”. Simons in 1941 (Simons cited in Forbes 1950: 13) defines Chalcolithic for “a culture which without exhibiting the character of a true Neolithic still precedes the first knowledge of metallurgy”. The Copper Age indicates the period where tools and weapons were generally made of copper. According to Frankfort the “Copper Age” may be better termed as “native metal stage”. According to Simons “native metal stage” represents the first steps of metallurgy with small production and influences. Evidences of copper and bronze widely vary from region to region and the classical sequence of Copper-Bronze-Iron could be applied in the Ancient Near East. The term Metal Age is used for the period lying between Neolithic and the Iron Age, where there are evidences of copper and other non-ferrous metal. Thus it is the stage placed between native metal and the introduction of iron technology. In Indian context the terminologies bear different meaning from those of European terminologies.

By summarizing the above discussion it may be said that universally “Copper Age” indicates the period where there is evidences of copper, mainly in the form of

native copper; "Bronze Age" signifies the period of extensive use of bronze; whereas "Chalcolithic culture" is defined by the use of both stone and metal simultaneously. Chalcolithic culture is an intermediary stage between Neolithic and Iron Age. The metals of Chalcolithic culture may include copper, bronze, brass and also iron.

In Indian context "Chalcolithic" has all the features of Neolithic culture with the presence of copper in small quantities (Sankalia 1974). V. D. Krishnaswami in 1960 used the term "Neolithic- Chalcolithic" to denote the Chalcolithic culture outside the Harappan civilization. The Neolithic- Chalcolithic in Southern India is found in Western Andhra Pradesh, Karnataka, and Tamilnadu. Sites of Neolithic-Chalcolithic culture are also distributed in Eastern Rajasthan and Eastern India. Chalcolithic culture is found in other parts of Andhra Pradesh, Karnataka, Maharashtra and Madhya Pradesh. In India the term Bronze Age is reserved for the Indus Civilization.

Agrawal defined Chalcolithic culture as "non-urban, non-Harappan cultures characterized by the use of copper and stone" (Agrawal 1982: 198). Therefore the term "Chalcolithic" may refer to the technological or economic phase related to the first appearance of metallurgy. It may also be considered as the gradual progression of the Neolithic societies continuing with the emergence of metal using communities and ultimately merging with the iron using cultures.

Sankalia (1974) used the term Neolithic-Chalcolithic for western Andhra Pradesh, Karnataka, Tamil Nadu and eastern Rajasthan; Chalcolithic for Andhra Pradesh, Karnataka, Maharashtra and Madhya Pradesh; Chalcolithic and Bronze Age culture for Sind, Punjab, Kutch and northern Rajasthan; Copper-Bronze age culture for Northern India comprising of Ganga-Yamuna Doab.

Eastern India comprising of Assam, Bengal and Bihar are Pure Neolithic in nature. However a number of metal objects have been excavated from different Chalcolithic sites in recent years with the Neolithic artifacts. Later the term Neo-Chalcolithic has been used also for the eastern India by many scholars (Sankalia 1974).

2.2 Hypotheses regarding invention and diffusion of metallurgy:

Similar to the other invention metallurgy began as a creative art from the desire of new material to serve as aesthetic visual display of social, cultural or ideological identity. Controversy exists regarding the place of origin and development of metallurgy in different parts of the World. One opinion says that metallurgy originated in South West Asia and diffused to the other parts of the world (Wertime 1964, 1973). Other opinion is that metallurgy originated in different parts of the World independently (Renfrew 1969).

Dating of different excavated and explored sites and objects may reveal new evidence for the origin and development of metallurgy. Different stages are estimated for the development for metallurgy. The stages are Native metal ore as stone, Native metal stage, Ore stage, Iron stage (Forbes 1950: 9). In the first stage native metals were treated as stone. The Native Metal Age is distinguished from true metal age by the fact that objects were made by hammering and cutting of metal bearing stone. Smelting of metal from ores is the primary invention of Ore stage which preceded the Iron Age. These phases do not occur uniformly nor are all the stages sequentially found in different parts of the world.

The process of origin is divided into two stages. The first stage is ‘invention’, the discovery of new conception, idea, and behavior. The second stage is ‘innovation’, the adoption and absorption of new invention within a society (Miller 2007).

2.3 Mining and processing of ores:

According to Birx “Metallurgy deals with the study of metals and their ores as well as the processes for extracting, purifying, and alloying metals and production of metal objects” (Birx 2006: 1586). It is interdisciplinary in nature consisting of different subjects like Geology, Physics, Chemistry, Mining and other applied sciences. Physical

metallurgy is concerned with the physical behavior of the metals like ductility, metallic luster, conductivity etc. In chemical definition a metal is a crystalline material in which ions are connected through the free electrons surrounding them. The attraction of each ion with many neighboring ions gives a close packed structure which is responsible for increased strength, high density, good electrical and thermal conductivity, ductility and reflectivity. Metallurgy is broadly classified into two: ferrous and nonferrous metallurgy. Ferrous metallurgy deals with iron whereas nonferrous metallurgy includes metals other than iron, such as copper, bronze, tin, gold, silver zinc etc. (Mishra 2009).

Neolithic people are ranked first to discover and use of metals. However archaeometallurgists inclined to believe that true metallurgy evolved when prehistoric men learnt the technology of reduction of metals from ores. At first they used simple metals then experimented with the technology of alloy making. Remains of the developments of the early metallurgy are found from the stratum of the earth with great care. The knowledge about the early metallurgy is still limited due to scarcity of archaeological evidences, which are sometimes too fragmentary. In archeological context metallurgical analysis is done to study the different metal artifacts, reconstruction of method of manufacture and sources of raw materials. The typological analysis of the materials is studied to know the similarities and differences of the objects found from different regions. Sometimes metallurgical analysis has been done to know the composition of the metals. Chemical analysis of metal artifacts are done by metallographic examination under both optical and electron microscope technique (Mishra 2009). These metallurgical analysis combined with the chronology is very important to know the innovation, development and diffusion of different metal technology in different parts of the world. Though the central focus of the present study is on the brass metallurgy in Eastern India but technology of copper work have also been highlighted as a primary constituent of the alloy. The brass technology of the Chalcolithic site Kuanr in Keonjhar district of Odisha have been reconstructed as a representative of Eastern India with the analogies of the technology as collected from different literary sources. These secondary data are also helpful to know the similarities and differences of metal technology which vary from site to site and region to region. Before getting insight

into the technology, definition and components of copper and its alloy have been studied. Zinc which differentiates the brass from bronze also is given due emphasis because it is one of the primary component of brass.

Ore is a natural mineral and sources of useful economic substances that can be extracted through smelting (Misra 2009). Early people collected metal ores from surrounding natural resources. Identification and collection of ores is the first step of metallurgy. Perhaps prehistoric men were familiar with properties of different ores and invented the technology of extraction of metals from ores. According to Tylcote (1962) the term native metal indicate the metals that are found in metallic state and not produced from ores by smelting.

Copper as a salmon- pink and highly ductile metal occurs in native form and contains impurities like silver (Ag), lead (Pb) etc. Atomic number of copper is 29 on the periodic table. Melting point of copper from its ore is 1083.4^0C and boiling point of 2567^0 C. In hieroglyphics it is represented by the *ankh*, which symbolizes eternal life. It is ignoble, fusible, and extensible under the hammer. The word copper is derived from Cyprus. Copper production and working is the earliest branch of metallurgy and it has immense consequences on the life ways of the Neolithic people. Copper was discovered as metal from its astonishing changes by fire. Copper is relatively soft metal suitable for cold working as well as casting for its low melting point (Mishra 2009).

Copper ore is widely distributed in nature from soil to water. Copper is present in igneous, sedimentary and metamorphic rocks in the form of veins and bedded deposition. Copper is extracted from different ores like Azurite [$Cu_3(CO_3)2(OH)_2$] which occurs as a secondary minerals and sometimes alters to malachite contains 55.1% of copper; Malachite [$Cu_2CO_{3.}Cu(OH)_2$] is found in the zone of copper veins have 57.3% of copper; Cuprite [Cu_2O] is found in upper oxidation portion of copper veins; Bornite [Cu_2FeSo_4] is found in hydrothermal deposits of ore and is combined with 55.5% of copper; Chalcopyrite [$Cu_2SFe_2S_3$] contains 34.6% of copper and is formed by the alternation of primary copper sulfides and found in zones of secondary formation; Covellite [CuS] has 66.5% of copper and is commonly found in sulfide enriched zones and sometimes

associated with Chalcocite, Chalcopyrite etc. The others ores are Chalcocite (Cu_2S) contains 79.8% of copper, Tetreahedrite ($4Cu_2S.Sb_2S_3$) have 52.1% of Copper (Agrawal 2000). The Greek *chalkos* or the Latin *aes* was used to denote copper as well as bronze or brass (Forbes 1950).

Zinc is soft bluish-metal of transition element. The atomic number is 30 and melting point is 420 °C (788 °F). Low boiling point i.e. 907 °C (1,665 °F) ^{0}C plays a crucial role in the extraction from the ore. Zinc has commercial value (Encyclopedia Britannica).

Tin (Sn) is a chemical element belonging to the carbon family. Atomic number is 50. It is a soft, silvery white metal with a bluish tinge, known to the ancients in bronze. The element is present in the igneous rocks of earth's crust of about 0.001 percent. So there is scarcity. Melting point is 231.97 °C (449.54 °F) and boiling point is 2,270 °C (4,100 °F) (Encyclopedia Britannica).

According to Thronton (2007) "an alloy is defined as the *intentional* admixture of two or more elements in order to create a distinct material with certain desired physical properties" (Thronton 2007:124). Common alloys found in archeological context are brass and bronze. There is a general misunderstanding about the interpretation of term brass and bronze. Sometimes it is also used wrongly. Brass is an alloy of copper and zinc while bronze is made by alloying of copper and tin. However the term bronze includes alloys of copper with elements other than or in addition to tin and also containing some zinc.

The classification of copper alloys was first suggested by the Metal Industry of London in 1938 and later considered by American Society for Testing and Materials (ASTM). According to the classification the term bronze is used for all copper based alloys with less than 90% of copper containing alloy elements other than zinc. Whereas the term brass is applied to all the copper zinc alloys which contain less than 98% of copper. Other metals may be present in small quantity which is subordinate to the quantity of zinc (Kirk and Othmer 1949). Earlier brass was not considered as an alloy

rather considered as special metal, namely 'mock gold'. Brass with 10-18% of zinc appeared as golden yellow in colour and glitters like gold. So it has been widely used for casting statuary, fabricating vessels and ornaments. As an essential component of brass, zinc is an important metal. The brass containing up to 36% zinc is known as α-brass. It is suitable for cold work. Brass with more than 46% of zinc is known as β brass, which is brittle in nature. Brass with 36 to 46% of zinc is known as α+β brass. This is lighter, harder and more suitable for casting (Bayley 1998).

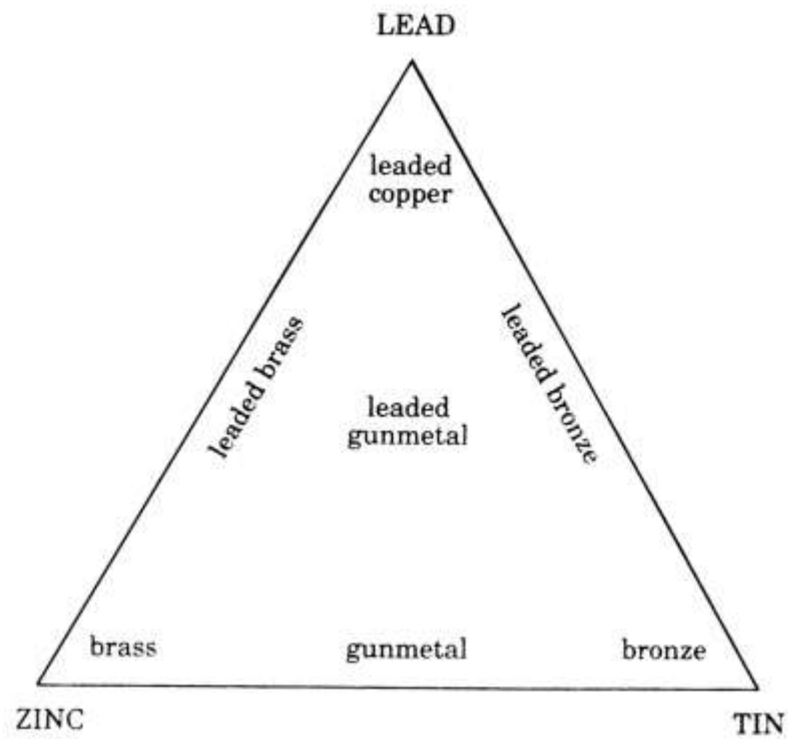

Figure 1: Ternary diagram showing the standard nomenclature for copper-zinc, tin, -lead alloy (after Bayley 1998)

2.3.1 Mining technology:

Mining technology has similarities with stone quarrying. Ores are dug out by antler, picks, stone mauls and scapula hoes. Many mines in the world were used in prehistoric period as well as are still used today. Collection of ores from open pit mines was found in India and Africa during prehistoric periods. Different techniques like fire setting and wedging were used to crack and loosen the blocks of ores from natural deposition. Downward cutting produce bell shaped pits. Shaft and gallery mining was introduced later. There was severe deforestation in the mining areas because timbers were widely used to prevent collapse of extensively excavated chambers of mines. Men were directly engaged in mining whereas women and children usually engaged in transport and cleaning of ores (Mishra 2009).

Ores after excavation is removed from mines and were crushed, sieved and washed. Then smelting was done generally by reduction of metallic oxides in a furnace. The charge of smelting furnace is generally composed of layers of fuel (usually coal) and ore. Limestone or other flux was also combined to separate impurities from fluid metal. Furnaces range from single pit type to the most common furnace built on the top of the ground.

2.3.2 Sources of copper in India:

At present mining areas of India are located in Rajasthan, Andhra Pradesh, Karnataka and Tamilnadu, Jharkhand, Garhwal-Kumayun belt of Uttaranchal, in Sikkim, Kumaon and Nepal (Agrawal 2000). Though there are minor deposition in Kashmir, Tibet and Jammu.

Andhra Pradesh: Concentrations of copper mines are found in Cuddapah, Guntur, Khammam, Kurnool, Nellore, Prokasham, Mahbubnagar and Nalgoda. Out of these, Guntur and Khammam are the most important. Native copper is distributed in Cudapah,

Guntur. Chalcopyrite is the primary copper ore in the area with some bornite, malachite and pyrite (Chakraborty and Lahiri 1996).

Maharashtra: Copper ores of Maharashtra are distributed in Nagpur, Chandrapur, Bandara and Ratnagiri districts. Chalcopyrite, arsenopyrite and pyrite are distributed with native copper in the state (Raghunandan *et al.* 1981).

Madhya Pradesh: The major copper sources of the area are Sidhi-Shahdol-Jabalpur belt where copper, zinc and lead ores were found (Raghunandan *et al.* 1981). In Malanjikhand deposition open cast mining is practiced by Hindustan Copper Ltd. The other copper bearing zones are Bastar, Chhatarpur, Gwalior, Jabalpur, Shivpuri, Bhilsa and Dewas. The copper ores are mainly Chalcopyrite, pyrite, malachite, azurite and tetrahedrite.

Rajasthan: The most important copper mines area is Khetri-Singhana in Jhunjhuna district. The other mining sites are *Khetri Singhana* in Jaipur district, *Kho-Dariba* in Alwar district, *Delwara ea. Korovli* and *Debari* in Udaipur district (Chakraborty and Lahiri 1996; Agrawal 1971). Chalcopyrite is the dominant copper core in these regions. The other cores are malachite, chalcocites. The slag pieces found are varying in size, shape and composition. Fragmented pieces of clay retorts, crucibles and other pots are collected from the heaps. Chalcopyrite ores from Khetri region have less than 0.5% arsenic. The earliest dated copper slags from Ahar are 2000 BCE and smelting furnace from the 3000 BCE. Though Agrawal opined that Khetri ores were used by both Harappan and Chalcolithic people but Kenoyer and Miller (1999) did not find any direct evidence of mining and smelting of Harappan phase in Aravalli region, however the copper ores perhaps were collected from nearby desert region of Cholistan, Pakistan along the dry bed of the Ghaggar-Hakra River. It appears that Harappans used copper from more than one sources. The earliest dates of ancient copper working in Rajasthan are 2310±105 BP and 2200±100 BP found in Dariba mines (Mishra 2009).

Gujarat: Native copper was found in different localities of Deccan trap. The important localities from where the copper ores were collected are Deri-Ambamat, Kui-Chitraseni

and Champaner. There are the evidences of copper mineralization in the Panch Mahal and Baroda district (Raghunandan *et al.* 1981).

Kumayun-Garhwal: The ancient sites of copper metallurgy in this area are Khan-garh, Agar, Chaugaonchhina, Dewaldhar. It is interesting that the name of the places having suffix ‘Agar’ were ancient mining and metallurgical centres. The expert miners known as Agri were living in Kharahi Patti. Copper was mainly extracted from galena, chalcopyrite, arsenopyrite, bornite, chalcocite, pyrite, pyrrhotite. In Rai irregulars burrows were dug which formed honeycombed structure. A skeleton was discovered impregnated with copper carbonate. The average composition of copper 2.32%, lead 2.64% and zinc 3.95% (Krishnamurthy and Krishnaswamy 1986).

Himachal Pradesh: The copper ores are mainly found in Shallu valley, Garesh valley and Parvati valley. The primary ores are chalcopyrite, pyrite, secondary chalcocite, malachite and azurite (Raghunandan *et al.* 1981).

Haryana: Old working of copper is found in Khodana and Narnaul area between Dhani-Umrabad and Khalra hills and in Teejanwali and the Luni hills (Raghunandan *et al.* 1981).

2.3.3 Ancient copper mines in eastern India:

In eastern India major sources of copper are distributed in Singbhum, Chotanagpur and Jharkhand copper belt. The most significant occurrence lies in the Singbhum-Hazaribagh belt of Jharkhand. The ancient copper mines were identified in Odisha, Jharkhand, Bihar and West Bengal from the exploration of GSI. In west Singhbhum district the old mining sites are Astakoale, Chapri, Charakmara, Dhobani, Duarpuram, Dugni, Galudih, Jaypur, Kendadih, Lankesera, Mosaboni, Purnapani, Rajadih, Rakhamines, Ramchandrapahar, Ruam, Sidheswar, Sini, Surda and tama Dungri. These mines are within $22^{0}17^{/}$N to $22^{0}47^{/}$N Latitude and $85^{0}34^{/}86^{0}28^{/}$ E Longitude. In West Bengal ancient mines were found from Chhedapathar and Tamakhum

in Bankura district; Beldie and Biramdih, Kantagora, Chirugora and Tamakhun in Purulia district; Gohalbaria in Midnapur. These are distributed within $22^0 05^/$N to $22^0 59^/$N latitude and $86^0 36^/$E to $86^0 45^/$E Longitude (Ball 1881).

In Odisha copper mines were located Sargipalli of Sundargarh district, Kusumbari and Kesarpur of Mayurbhanj district. Common form of copper ores found in the area is chalcopyrite, chalcocite and native copper. Furnace and slag were reported near old copper mines (Chattopadhyay and Sengupta 2011).

2.3.4 The process of extraction of copper:

The technology of copper extraction from chalcopyrite was well adapted in eastern India by mixing of cow-dung, clay and wood charcoal in a cylindrical crucible furnace (Datta and Chattopadhyay 2007). The processes include three steps. At first stage air was blown from the top through tiers and iron sulphide present in the ore was oxidized to iron oxide. Slag notch attached at the bottom removes the slag produces. In the second stage copper was smelted in 1200^0C with silica sand (SiO_2) which separate the gangue component (iron) from the fluid. The third step is the removal of slag through the slag notch. Copper rich metal known as ‘white metal’ (80%) is collected then converted to blister copper (Chattopadhyay and Sengupta 2011).

Plate 1: Copper furnace of Singbhum (after Srivastva 1999)

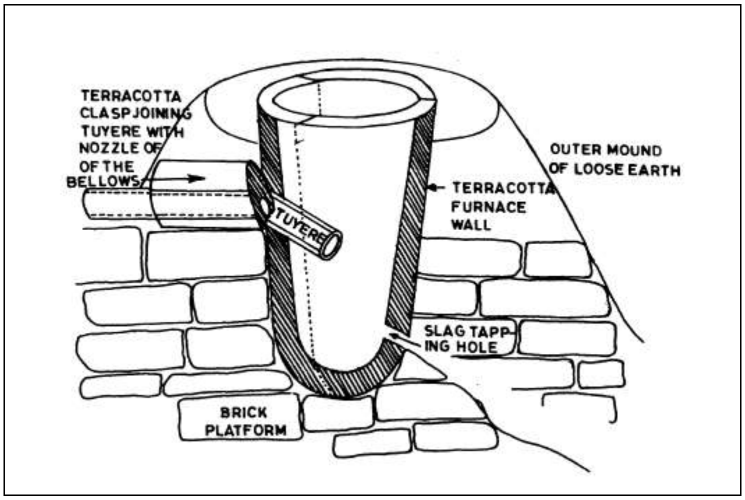

Fig 2: Copper smelting furnace from Aravalli (after Srivastva 1999)

2.3.5 Zinc mining in India:

Zinc ores are widely distributed in India with the main concentrating zone in the Aravalli. The Aravalli range in Southern Rajasthan is composed of pre-Cambrian metamorphic rocks rich in zinc ores. The largest zinc-lead deposits have been discovered at Rampura-Agucha in Bhilwara district of Rajasthan. The well known ancient lead-zinc workings are located in the Zawar area of Udaipur district of Rajasthan. The earliest C14 dates of Zawar mines are 430± 100 BC. According to Misra (2009) the C-14 date at Zawar mines goes back to 755-685 BCE and its maximum frequency is found during Medieval period. The host rock in the Zawar mines are dolomite and arkosic (quartz and feldspar). These contain a variety of sulphide minerals, such as sphalerite (ZnS), galena (PbS), sulphides of iron, copper, silver etc. Zinc is generally found in veins in association with other ores like galena, chalcopyrite, ironpyrite, silver, cadmium and other sulphide ores. The Zawar mineralized belt extends over approximately 25 km. The remains of early mining were found from Zawarmala, Mochia Magra, Balaria and Hiren Megra in the form of deep trenches, shafts, open stopes, long galleries and inclines. The mines are 10 to 300 meter in length. The mound of slag and smelting debris indicates that mining continued for several hundred years. The ancient

mining in Rajpura-Dariba mines is dated from 1260 BCE to 150AD (C14) (Biswas 2001). The earliest emphasis was on copper in addition to lead, Silver and zinc ores. The host rock of Zawar is metamorphosed compact dolomite. The abundance of evidences of charcoal waste and ash on the floor of the old mines indicated mining by fire setting method. Mining in the inner side was done methodically with clean floor and oil lamps in regular intervals. There was also the facility of water in large earthen jars. For transportation of ores good pathways were made with wood and stone. Ores were broken by hand and sometimes by stone hammer technique as per the evidence were found at the outer slopes of the hills. Several uncovered banks of furnaces with 36 retorts each have been found in recent excavation. The earliest date of the Zawar is found from the Mochinda and Zawarmala which shows the evidence of mining of zinc between the 6th and 1st centuries BCE. The earliest date of distillation of zinc is about 12th Century AD (Craddock 1987).

Though Rajasthan is the main source of zinc however there are a number of other zinc mines distributed in India (Chakraborti and Lahiri 1996). Zinc mines are distributed in the states of Kashmir, Himachal Pradesh, Uttar Pradesh, Madhya Pradesh, Gujarat, Andhra Pradesh, Tamilnadu and North Eastern region. In Eastern India zinc mines are found in Odisha, Jharkhand and West Bengal. For example Amjhor and Golgo in Jharkhand, Kushaboni-Gohalbaria in Midnapur-Purulia districts in West Bengal. The common zinc ore in this area is sphalerite, a sulphide of zinc (ZnS) and perhaps was exported to Bangladesh (Chattopadhyay and Sengupta 2011).

2.4 Antiquity of copper:

Copper is the mother invention of metallurgy. At the first stage copper ores were directly used in the form of different ornaments. The core area of invention and development of metallurgy is Southwest Asia. Blue and green copper ores were used to decorate the human body in life and death in Neolithic period in this region. The dates are between 11th and 9th millennium BCE (Roberts *et al.* 2009). These dates are found at

different sites such as Shanidar cave and Zawi Chemi in north-eastern Iraq, Hallan Chemi in Eastern Turkey and Rosh Horesha in Israel (Yener 2000; Bar-Yosef Mayer and Porat 2008). The exploitation of native copper was flourished in this core area by late 8th millennium BCE. The evidence of annealing with the application of heat is found from Cayonu Tepsi in Eastern Turkey around 8000 BCE (Maddin *et al.* 1999). Beads, pins, tools made of copper were found from pre-ceramic Neolithic stage at Cayonu Tepesi around 7570 and 7250 BCE. Copper awls, copper wires were found from Suberde Neolithic phase around 6600 and 6200 BCE. Beads, natural piece of copper and copper knife were found from Tell-Es-Sawwan around 5506 and 4858 BCE (Sing 1974).

The exploitation of native copper flourished in this core area by late 7th millennium BCE and it appeared outside the core area by the late 8th millennium BCE. It spread to Tell Ramad approximately in 5950 BCE in south-western Syria (Golden 2009) and from Ali Kosh in South Western Iran around 6750 and 6000 BCE (Piggot 1999, Hole 2000) reached to the Mehrgarh in central Pakistan by 6000 BCE (Kenoyer and Miller 1999).

Metallic copper was known in Badarian culture around 4400 and 4000 BCE of in Middle Egypt. The culture yielded few copper tubes. Native copper was also common in Naqada I around 4400 to 3500 BCE in Upper Egypt. These were not smelted from ores. Copper was used to make small tools like harpoon and pin with rolled head. These were cut from hammered copper sheet. Various types of cast copper tools have been found from Gerzean period around 3500 to 3200 BCE of Upper Egypt. Copper tools like flat axes with expanded blades, copper dagger with ivory handle, knives were produced by casting method by copper smith. The regular use suggested that there was contact outside the Nile Valley, with the Eastern Desert also with Sinai (Childe 1958).

Artifacts made from native copper were identified from Neolithic Mesopotammia. Ornaments include rings, beads and bracelets found from Yarim Tepe I and II. Copper awl was found from Tell Maghzaliyah (Stech and Piggot 1986). Small beads from metallic copper have been found from Halaf culture around 6500 to 5500 BCE. A harpoon from Ur and an axe of Arpachiya have been found from Ubaid culture of

Mesopotamia in 5000 BCE. The scarcity of copper is reflected in the carefully preserved copper for reuse. Smiths of Urek period learned alloy making with lead and casted them in cire-perdue method. Copper vessels and fish hooks were discovered from succeeding period at Jamdet Nasr. Copper was available in Susiana. Flat axes, chisels, needle with eyelets and mirror made of copper were found from this site. Varied local tradition of metallurgy developed in Egypt, Mesopotamia and Indus valley (Childe 1958).

Early copper smelting sites occur in areas which are far from the Fertile Crescent. These are Tal-i-Ibis (Roberts *et al.* 2009) in South-eastern Iran and Belovode in eastern Serbia (Boric 2009) developed in the late 6th millennium BCE or early 5th millennium BCE. Copper production was common in Eastern Turkey and began in the southern Levant and in Central Europe at Brixlegg in Austria (Hoppner *et al.* 2005). Anatolia was probably the core area of use of naturally occurring copper for several thousand years and copper smelting appeared synchronously throughout Southwest Asia and Southeast Europe. These evidences prove single core area of origin of metallurgy in Southwest Asia (Roberts *et al.* 2009).

Copper ores with natural impurities of arsenic and lead were exploited throughout Southwest and Central Asia and Southeast Europe in late 5th millennium BCE or in early 4th millennium BCE. These impurities made the copper harder and suitable for casting in the form of alloy. Copper alloys of arsenical and antimonial copper were produced intentionally by the mid-fourth millennium BCE. These were used for making prestigious objects as per the evidences of Nahal Mishmer hoard from Israel (Golden 2009). Copper objects have been found from western and northern borders of China from the late 4000 to early 3000 BCE. They had link with metal working communities of Eurasia (Chernykh 1992, Mei 2000).

Based on both linguistic and archeological data, copper metallurgy in South-East Asia goes back to 6th millennium BCE. Copper working in Thailand dated around the first half of the first millennium BC (Piggott and Natapintu 1988). Copper production of Thailand dated around the 1st millennium BCE (White and Piggott 1996). The evidence of ancient mining of malachite native copper in Vietnam was dated around the second

half of 1st millennium BCE. There was ancient trade route along the Mekong River from the north. Both linguistic and archeological data suggests that there was a link with the Indian Copper Hoards culture through the Himalayan corridor (Agrawal 2000).

According to metallurgy had started in different regions around later part of 3rd millennium BCE. The earliest copper mining and smelting in Jiangxi province dated around 14th century BCE. In America metallurgy began independently from Eurasia around c. 5000 BCE. The cold-working of native copper was found in the eastern woodland of North America (Roberts *et al.* 2009).

2.5 Antiquity of bronze:

Bronze is an alloy of copper and tin. As per archeological evidences Bronze was first developed in Southwest Asia by the end of the 4th millennium BCE. Then in Central Europe and Central Asia bronze metallurgy was developed by the early 3rd millennium BCE (Primas 2002; Thronton 2007). Tin was imported from Central Asia to Troy and from southeastern Europe to Trod for development of tin-bronze metallurgy (Glumac and Todd 1991). In Egypt and Mesopotamia bronze metallurgy was developed around 3100 B.C. (± 150 years) then spread to Syria and other areas of eastern Mediterranean. In Egypt there was no tin ore. Perhaps tin was supplied from Transvaal and Rhodesia of Africa. Perhaps tin of Zimbabwe directly sold it to Hindu merchants not before 300 to 400 years ago (Forbes 1950). Perhaps tin was obtained from Afghanistan by Sumerians, then Akkadin and Assyrians (Stech and Pigott 1986). There was decline of bronze consumption in 2nd millennium BCE, mostly for funerary function. It might be regarded as material with specific status (Stech 1999). Copper using stage or Chalcolithic period was absent in Middle East and Europe whereas Bronze developed in full- fledged form. However in the 3rd millennium BCE there was shortage of bronze making due to exhaustion of local tin deposits and copper metallurgy again reappeared in Mesopotamia.

Use of bronze in Indus Valley in India developed as early as 2700 B.C. This is coincident with those of Near East. It is quite interesting to note that Bronze did not enter at all in Africa or Oceania. Varieties of copper alloy; namely, arsenical copper and tin-bronze alloys were smelted from local ores in north-west China by the beginning of the 3000 BCE and in central China dated to mid-2000 BCE. It was due to rapid adoption rather indigenous invention (Linduff *et al.* 2000). In Thailand and Vietnam tin-bronze metal production emerged from the early to mid-2000 BCE (Higam & Higam 2009).

The above discussion implies that copper and tin-bronze metallurgy in Eurasia originated in Southwest Asia by agricultural and agro-pastoral economic set up around 11th to 9th millennium BCE. By 2000 BCE it spread across Eurasia. As per the demands and desires of society Smelting developed in different way as a result of regional innovation. The knowledge of metal technology and production organization within a social system perhaps has been shared within a vast territory (Roberts *et al.* 2009).

2.6 Background information of technology (copper and bronze):

The first metal used by the Neolithic men is copper. The earliest evidences come from Western Iran and Anatolia between 8000 to 7000 BCE. These were made from native copper which was not melted. The earliest evidences of crucible furnace were found from Abu Matar in Israel dated between 3300 and 3000 BCE. However the earliest furnace with bellows was noticed from Ahar in Rajasthan. The earliest evidence of copper slag found at Catal Huyuk in Anatolia dated to 7000-6000 BC and the earliest cast native copper was found from Silak in Iran dated to 4500BCE. The earliest Egyptian copper artifacts dated from 5000 to 4000 BCE. The technique of melting and casting native copper originated in Anatolia between 5000 and 4000 BCE and at the end of this period the supply could not meet the rapid increasing demand and began to extract copper from the ores (Agrawal 2000).

The presence of arsenic proves that copper was extracted from sulphide rather than oxide or carbonate ores. At the beginning of metallurgy sulphide ores were exploited. Gossans is a rich iron oxide deposition above the rich copper deposits. The copper content deposited in the form of sulphide in the surrounding strata. The foundry process developed in Sumer by the early 3000 BCE. Most of the copper artifacts from Ur were fabricated from sheet metal before 3000 BCE. Copper artifacts produced by casting method developed about 2700 BCE. By 2500 BCE Egyptians had developed the production of hollow copper and bronze statuary. Egyptians were master of Cire-perdue (lost wax) technique of casting developed before 2200 BCE.

The Bronze Age emerged in the mid-2000 BCE. After that the usage of bronze throughout Europe and Mediterranean region began to increase rapidly. The world famous Shang Bronzes developed between 1400 and 1027 BCE (Darling 1990).

The first interface of Roman with metals was of brass for making of coins. Roman bronzes also contain comparable quantities of zinc and tin. The arsenical copper of Middle East began to decline after 3000 BCE. Low tin (less than 2.5%) bronzes first appeared in Iran around 3000 BCE. The coppersmiths discovered the method of alloying in the form of bronze around 3000 to 2500 BCE and expanded in West Asia (Darling 1990).

Region wise differences of making of copper alloy were described by Muhley in 1980. Arsenical bronze was common in Crete whereas tin bronze is found in Troad. Both the types are equally used in Central Anatolia. Egypt has the evidence of arsenical bronze. The technology of bronze making was acquired by the Sumerians around 3000 BCE. Due to the shortage of tin the use of bronze with 8-10% of tin expanded rapidly throughout the Middle Eastern world. Bronze Age also developed in Southern China, Thailand and Indonesia. Chinese bronzes with 8% of tin emerged as early as 2800 BCE. The earliest tin bronzes were found at the sites of Tepe Giyan in Western Iran dated to 4000 BCE then appeared suddenly at Ur around 2800 BCE and Amuq in Turkey about 3000 BCE. So the concept of bronze developed in the Persian highlands during 4000 BCE and moved southward to Sumerian and Persian Gulf and westward to the

Mediterranean area. Bronze was first made in Italy between 1900 to 1800 BCE. Native copper was used from 3000 BCE in North America (Agrawal 2000).

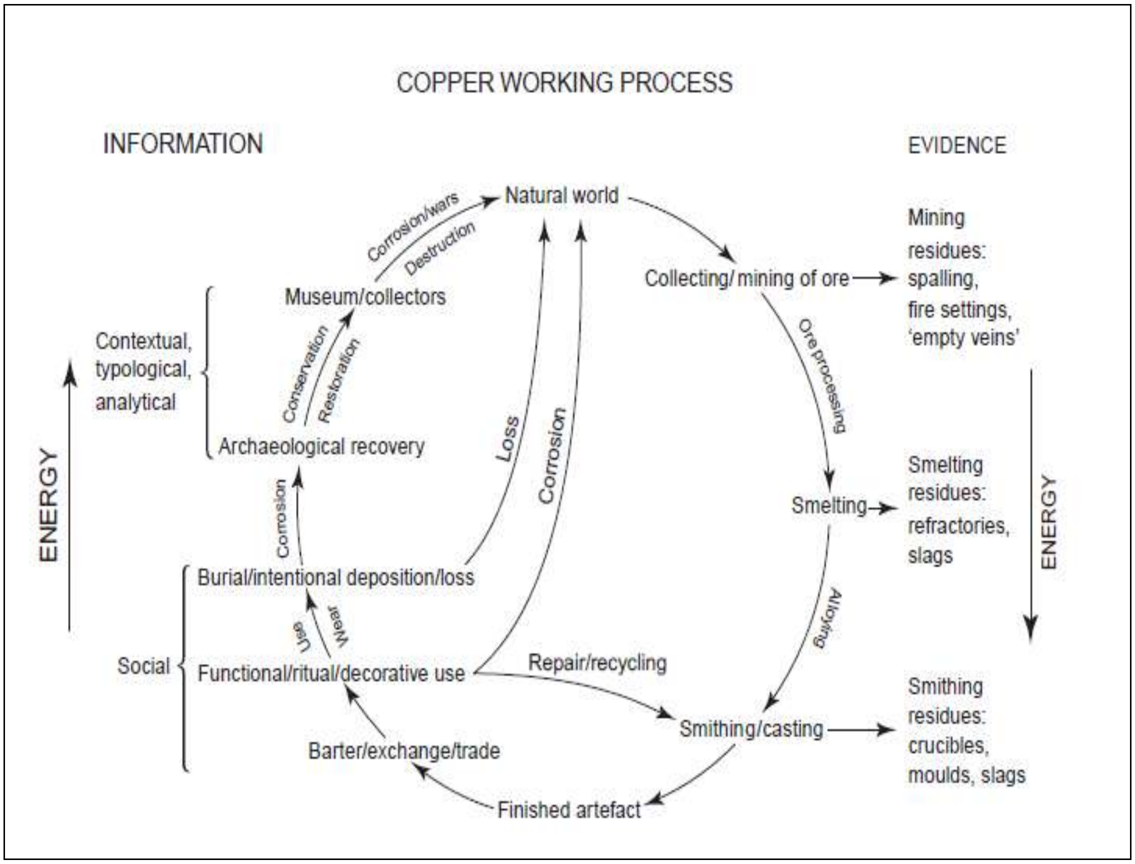

Fig 3: Cycles of copper production and technology (after Ottaway 1994)

2.6.1 Shaping of native copper (Native metal stage):

The earliest stage of making copper artifacts, perhaps the shaping of native copper, appeared about 8^{th} to7^{th} millennium BCE. This was considered as the earliest stage of metallurgy a It looks like purplish green or greenish black nodule and when hammered looks like gold. This was too brittle in nature. Native copper is soft and can be shaped and hardened by hammering. They used cold hammer techniques and fashioned

metal objects just like the stone tools technology, such as, hammering, cutting, bending, grinding and polishing. These types of copper implements were found from Egypt and Mesopotamia (Forbes 1950).

2.6.2 Annealing of native copper:

This is the next step of metallurgy. It followed alternate heating and hammering, discovered about 5000 to 4500 BCE. Earlier copper was used for making ornaments but by annealing it was possible to shape into different forms. The first metal smiths probably experimented the native copper with 'heat- test'. The hammering is done after softening of the metal in fire. Hammered native copper is identified with typical 'twinned' microstructure and cast pieces show the typical 'cored' microstructure (Forbes 1950).

2.6.3 Reduction of copper from ores:

The copper ores are classified into two types. The copper ores are classified into two types. The primary ores are oxides, carbonates and silicates. These are refined by heating and reduction of the ore with charcoal and wood with the help of blast air in technically made furnace.

The purification of the sulphide ores is complicated and it has lot of impurities mainly in the form of sulphur, arsenic and antimony, which have bad effect on the quality of copper. There are different stages of reduction of ores. The first stage is roasting the ores to remove arsenic and antimony compounds. Sufficient heat is maintained for roasting until the end. The second stage is the smelting of the roasted ores to a mixture of copper and iron sulphides known as "copper matte". This is done by the smelting with charcoal fire in a shaft furnace. The coarse metal is smelted with charcoal and siliceous fluxes. It purifies the copper sulfides and help to remove the iron oxides present in the form of slag. This is called 'blue copper' which is again resmelted with charcoal and

fluxes with blast air in a shaft furnace. The remaining iron sulfides oxidizes and slag is formed. 95-97% pure copper is formed in this stage. This is called the ‘black copper’ which is again refined in the next stage and the impurities are removed by oxidation. The impurities are almost removed and copper oxides is effected by ‘poling’ that is the intrusion of the log or trees under the molten metal. This process of purification was developed through the ages. The early purification of copper ores may not follow all the stages but the presence of impurities helps archaeometallurgists to know the process of purification of copper ores (Forbes 1950).

There are some ethnographic examples of purification of copper found at present day. The Chetri community near the Aravalli hills of Rajasthan used different methods of purification of copper sulphides. They crushed the sulphide ores and mixed it with cow dung and dry in the form of ball. These balls are roasted and smelted in a furnace which is filled with alternative charcoal and roasted ores. The indigenous community of Persia roasts their sulphide ores in a cone shaped mud furnace about 7inches high with air holes and doors. The roasted ores are smelted in a blast furnace. The Japanese used very old method. The roasting and smelting of ores is done in a simple hole in the ground with blast air from hand blows (*fuigo*) and foot bellows (*tatara*). Then it is refined in crucibles made of clay and chapped straws. The Negroes of Katanga used more complicated purification method of copper than Japanese. The Basenga clan keeps the technology secret. They collect malachite from soft siliceous dolomite. Collected ores are crushed and washed in stream water. Then two furnaces are built from termite cones and filled it with charcoal and wood. Then ignites it again, filled up with ores and charcoal layers. Black copper is produced after roasting. There is a ritual performed during the process. Water and bits of barks of six sacred trees are added and incantations are chanted throughout the work. This black copper is again mixed up with the charcoal and smelted in a crucibles made from termite cones. These copper is casted in moulds and formed into ingots (Forbes 1950).

2.6.4 Melting and casting of copper:

New methods of forming the metal were introduced with the introduction of casting. Earlier the metals were smelted in open crucibles. In casting method is generally done in closed crucibles. Gradually casting method developed into more complicated forms, such as core-casting and the cire-*perdue* methods. These methods have number of stages, such as, making of clay mould, covering with bees wax, making of crucibles and casting in covered mould. Both the native and smelted copper has small percentage of impurities. Impurities found in ancient copper are 3% and it influences the hardness of the casting materials (Forbes 1950).

Gradual evolution of copper metallurgy is doubted. The typological analysis of the artifacts shows that the refinement of the structure developed with the growing skills of the earlier metallurgists. Coppers occur in a native stage in different parts of the world during Neolithic period. Native copper usually have no nickel. Native copper ores centers of Middle East and Europe are very rich. Central Anatolia was perhaps one of the important copper mining centers of West Asia. Mesopotamia perhaps imported copper from Anatolia. Assyrians imported 'bad' (black) and 'good' (refined) copper from Asia Minor dated between c. 2400-2000 BCE and c. 1500-1200 BCE. Cyprus was an important copper production center and exported to Egypt, Syria, Anatolia, Crete and the Aegean world. In Palestine copper was imported from the North. The main source of Egyptian copper was Sinai, Cyprus and Armenia. The evidences of crucibles, slags and copper objects indicate that smelting of ores was practiced in pre-Dynastic times. Copper mining area of Palestine and Syria dated back to c. 1800 BCE. There are a number of copper mines in Italy and Central Europe. Early mining and smelting is identified by the evidence of copper ores, ingots, slags, metal prills on crucible (Forbes 1950).

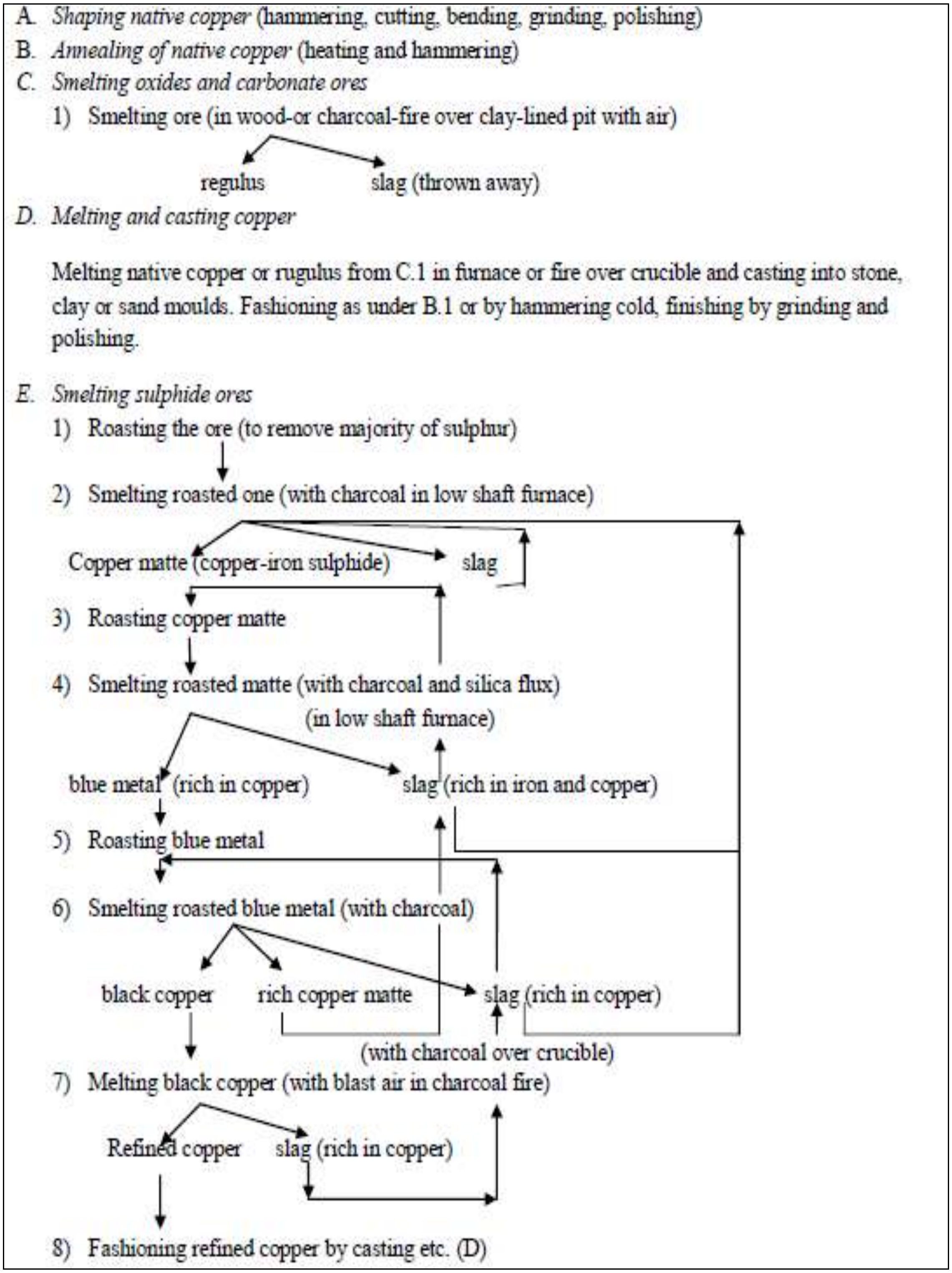

Fig 4: Stages of early copper metallurgy (After Forbes 1950)

2.7 Copper and bronze of Indus valley civilization:

Indus valley civilization has number of contributions in the development of different cultural traits in other parts of Indian subcontinent. Metallurgy is one of the important traits of them. Due to extensive and overlapping exchange network with the areas of West Asia, eastern Iran and Rajasthan, it is difficult to understand the exact source of metal technology from where it was diffused to Indus region. Harappan peoples were expert in different metal works of copper, tin, arsenic, lead, silver, gold and electrum. Gradual changes in different aspects of metallurgy are noticed from the evidences of Indus civilization. A wide variety of vessels and mirrors; ornaments (pendants, bangle, beads, necklace); tools and weapons (axes, arrow heads, spear points, knives, blades, projectile points, razors, fish hooks, sickle, drills); stamp seals and figurines made of copper and bronze were found from different sites of the Indus. Copper beads were common in Neolithic period and other objects appeared from Chalcolithic phase as a supplementary material without replacing the previous materials. Metal mirror was new invention of Harappan phase. According to Kenoyer and Miller "….metal objects were not simply utilitarian or symbolic, but that they played a variety of roles in the economy, technology, and socio-ritual/ornamental aspects of the Harappan Phase" (Kenoyer and Miller 1999: 133)

There are a number of metallurgical remains recovered from Harappan phase but unfortunately a few of them were subjected to metallurgical analysis. While considering Indus Valley civilization use of native copper started from the Mehrgarh Period I, which belonged to Neolithic period around 6000 BCE. By the 4000 BCE and 3000 BCE the mining and smelting of ores were practiced throughout Baluchistan and Afghanistan.

Baluchisthan tradition is well demonstrated by Mehrgarh. Native copper was discovered from Mehrgarh period I, which belongs to aceramic Neolithic phase of 7000 BCE to 5500 BCE (Possehl 2009). Period II of Mehrgarh is a ceramic Neolithic phase of 5000 BCE to 4800 BCE. The copper drills and the use crucibles for copper smelting found from the period shows the technological innovation of metallurgy.

2.7.1 Early Harappan Phase (3300-2600 BCE):

The evidences of copper also have been found from early Harappan sites of Sind, Baluchisthan and India. The Early Harappan metallurgical tradition is found in the form of copper from Naushrao, Bala Kot, Ghazi Shah, Rehmandheri and Kalibangan (Kenoyer and Miller 1999). A variety of copper implements i.e. adzes with straight or convex edge, saw with presence of teeth, chisel, circular seal were found from Nal (Hargreaves 1929). Two kinds of shaft hole axes of bronze were noticed in Mundigak period III. Simple type of bronze point or punch with circular cross section was common metal objects from Period I to IV. Number of metal artifacts increased throughout the sequence (Shaffer 1978). Few copper ornaments were found from Mehrgarh Period II. Copper ingots and fragments of crucibles with traces of melted copper were found from Mehrgarh II, Coper artifact including chisel, axe and double-spiral headed pins were found from Mehrgarh Period V (Jarrige and Lechevallier 1979). A bull shaped seal and a spear head made of bronze were yielded from Nausharo sub-period IC (Jarriage 1990). Use of copper and bronze was yielded from Gumla Period II (Dani 1970-1971). Bangle and Celt made of copper were found from Kalibangan Period I (Ghosh 1952). Copper ring, bangles, awl, chisel were reported from Ghazi Shah (Flam 1981). Fragments of copper and bronze were excavated from Amri period I and fragments of bronze bangle was reported from Kot Diji. Copper objects were found from Lothal Priod I (Allchin & Allchin 1996). Copper and bronze was also found from Period II in Gumla and copper-working was noticed in Dholavira (Agrawal 2000).

Analysis was done on few Pre-Harappan metal objects. Bronze of Mundigak include 1.06% of tin. Tin is absent in bronze discovered from Nal (Agrawal 2002). As per the evidence from Mehrgarh and other early sites the invention of pyrotechnology and metallurgy of Neolithic-Chalcolithic period set the technological milieu of metallurgy of Harappan civilization (Jarriage and Lechevalier 1979). Sedentary agriculturist and semi nomadic pastoral communities throughout southern and northern Baluchistan, Afghanistan and Rajasthan were familiar with the properties of ores and technology of

metal extraction from ores. There was overlapping economic and social network among the highland communities of West and South Asia (Kenoyer and Miller 1999).

There are rich sources of metal and fuel throughout West Asia and South Asia. Different regional styles of pyrotechnology were developed according to the physical characteristics of ores locally available in this region (Kenoyer and Miller 1999).

2.7.2 Harappan Phase (2600-1900 BCE):

Information on most of the published metal objects was from excavated sites of Harappa, Mohenjo-daro, Chanhu-daro, Lothal and Rangpur. Copper and its alloy are the most common metal objects from the site Mohenjo-daro (Agrawal 1971, Chakraborty and Lahiri 1996). The basic metal tool types are flat axes, chisel, knives, spear heads and arrow heads, small saws, etc. These were made by simple casting, chiseling and hammering. Dagger knives with flat tang appeared in the Upper level of Mohenjodaro, though developed from the lower level. Various copper and bronze vessels, covers were excavated. The common forms were handi, dishes, vases, jars, lids even frying pans and such other household items. Bronze appeared in the lower level but most common in quantity in the upper level. Four categories of metal objects are there namely crude copper lumps, refined copper with trace elements of arsenic and antimony, arsenical copper and tin bronze (SanaUllah 1931) . The most significant bronze specimens of Mohenjo-daro is a figure of a naked dancing girl of about 11.5 cm in height, with right arm resting on the hip and heavily bangled left hand. Others are two cast bronze feet and animals like a buffalo and a ram.

The copper weapons perhaps had been made by casting, chiseling and hammering. Knives with mid ribs and flat tangs, discovered from upper level of Mohenjodaro, show foreign influence but according to Childe’s remark they are ‘technically very Indian’ (Allchin & Allchin 1996). Metal objects made of copper and copper alloys excavated from Harappa include chisels, awl, daggers, celts, needles (point and eye end), rectangular rods, spear heads, saw, lance heads, mirror, spherical beads,

spear points, blades, large hooks and finger rings. Copper and copper alloyed artifacts excavated from Lothal are spear, knives, spear heads, engravers, pins, rods with grooves, daggers, chisels, axes, arrow heads, hook, fish hooks, figurines, lumps, shaft hole axes, celts, arrow heads, ingots, mirror and figurines. Ornaments like ear ornaments, bangles, rings make up rest of the metal objects (Kenoyer and Miller 1999).

A little model of bullock-carts and '*ikkas*' from Chanhudaro and Harappa shows the efficient skill of metal casting (Allchin and Allchin 1996). A number of blade, arrow head, knife, drill, spearhead, socketed axe, fish hooks, beads and bangles were found from Surkotoda in Kutch (Joshi 1990). The copper objects from Rangpur are knives, needles, celts, pins and ornaments are amulet, bangles, finger rings, and beads (Rao 1963). Out of 521 analyzed objects from Chanhudaro 64% are tools, 26% are ornaments, 7% are vessels and 3% are miscellaneous objects (Miller 2000) Chanhudaro copper-bronze objects include vessels like jars, pots, bowls, dishes, lids and ornaments like long pins, thin rods with elaborate ends, bangles, coils, beads and Weapons like arrowheads, blades, shaft hole axes and rods. Copper based metal implements found from Rojadi, a Harappan site of Gujarat consists of axe, bar, celt, parasu, pin, ring and bangles (Chitalwala 1989). Copper objects collected from Dholavira are few spacers, rings, bangles, blades, arrow head and chisel (Bisht 1991).

The collection of copper objects from Banawali are arrow-head, spearheads, a fragmentary sickle blade, razor, chisel, ring, pins, ear ring, nose ring and fish hooks. A fragment of bonze bangle was found from the Harappan phase of Kot Diji (Khan 1965).

Copper/bronze objects excavated from Sarai Khola Period II comprising of spearheads, needles, nail-parers, pins, rings and bangles (Halim 1970-71). Copper objects were recovered from Rakhigarhi (Possehl 2009). A number of newly excavated Harappan sites in Pakistan yielded evidences of copper and remnants of past metallurgy namely Loal Mari, Dubi-4, Taloor-ji Bhit, Bhir, Ganero-8, Lakhanjodaro and Bhob Bhir (Mallah 2010). A number Harappan sites of Haryana yielded evidence of copper from Girwad and Mitathal in Haryana, India (Shinde *et al.* 2010).

Out of 24 analyses of metal objects 12 have more than 1% tin (SanaUllah 1931) and in Harappa 9 out of 29 metal objects contain more than 1% of tin. In Lothal few objects are alloyed with tin. Out of 64 analyses 8 have more than 1% of tin (Lal 1985). In Rangpur 7 out of 12 objects contain more than 1% of tin (Agrawal 1971, Rao 1963).

Out of the total copper bronze assemblage of Chanhudaro 64% is tools, 26% are ornaments, 7% are vessels and 3% miscellaneous objects (Miller 2000). Few bronze objects found from Harappa and Mohenjo-daro contains insignificant amount zinc from 0.07% to 1.2%. However true brass object has not been identified from any Harappan site (Kenoyer and Miller 1999). About 70% of analyzed metal objects of Harappa are not alloyed and only 14% are alloy contain 8 to 12% of tin. It indicate that tin was scarce in Harappan civilization (Agrawal 2002).

2.7.3 Late Harappan Phase (1900-1000 BCE):

This phase is also termed as Post-Harappan phase. Five geographical zones of late Harappan culture are Sind, which is represented by Jhukar culture; West Punjab and Ghaggar-Hakra valley, which is represented by Cemetry-H culture; Eastern Punjab and Haryana, Ganga Jamuna doab; Kutch and Saurashtra (Sing 2013). Copper and bronze objects were found in Jhukar phase. The cemetery in Shahi-tump yielded copper stamp seals and a copper shaft-hole axe. Copper pins with spiral loops also were found from Chanhudaro Period Period IV. Different and new types of metal objects indicate either the increase of foreign trade or immigration of the population after break down of the urban system (Allchin and Allchin 1996). In Kutch and Saurashtra late Harappan phase is represented by Lothal III, Rojadi IIB, Rangpur IIIB and earlier settlement of Somnath. Copper tools are found throughout these sites but there is dearth of metal objects in Rangpur (Sankalia 1974).

In Baluchistan Copper stamp seal, pins with spiral loops first appeared in Mundigak period IV and continued to Period V. From the site Pirak in Kachi plain a number of copper objects were collected. These are mid–ribbed sword and a round seal

with geometric design, and a raised and pierced handle. Bronze dirk with fan shaped decoration were found from the Fort Munro. A number of bronze objects including tripod jar, horse bells and bangles were found from Moghul Ghundai in the Zhob valley (Allchin and Allchin 1996).

2.8 Sources of copper in Indus valley civilization:

The major sources of copper of Indus Valley Civilization are Baluchistan-Afghanistan, Rajasthan and Oman. These are the combined areas of Baluchistan and Afghanistan and inland mountain range of modern Oman to the Arabian Sea. The third area is to the east of the Indus and Ghaggar-Hakra valley combined with the Aravalli mountain region of Rajasthan. There are numerous evidences of concentrating zone of copper ores with zinc, lead and silver ores. The earliest area of copper processing is Baluchistan-Afghanistan area. Major copper deposits are found in Kabul and Loghar provinces. Copper occurs in the region of Southern Afghan Seistan in the highland plateau, approximately dated to 2500 to 2400 BCE. There are evidences of mining, processing and smelting of copper ores. Copper occurs widely in Baluchistan in the form of Chalcopyrite, malanchite. The Sandak mines are dated to 3500-3000 BCE. Copper ores were smelted in a mud furnace with wood and fuel. Harappans had great connection with Oman. The Omani copper ores have similarities with the Aravalli regions of Rajasthan because of the absence and presence of arsenic in small quantity. This is also different from the Iranian ores. They have higher concentration of nickel, cobalt, vanadium, chromium. The similarities of the composition of copper ores and Harappan implements suggest that Oman was the major source of Harappan copper. Copper items of Harappa and Mohenjodar, two important urban centers of Indus Valley, have less than 1% of arsenic whereas arsenic is absent at Lothal and Rangpur of Gujrat. The probable sources of arsenical copper were Baluchistan, Afghanistan and eastern Iran. Copper from the Aravalli or Oman also was used mixed with arsenical copper objects through remelting or recycling. Copper of Lothal and Rangpur was imported from Oman rather than Rajsthan but not from Baluchistan (Kenoyer and Miller 1999).

Sanaullah (1940) made a comparison of Harappan and Mesopotmian metal objects. Arsenic is present in Harappan copper objects but absent in Mesopotamian objects. Smelting of sulphide ore was prevailed from early Harappan phase probably mined from Khetri in Rajasthan (Misra 2009).

Early methods of mining and processing of ores have been reconstructed on the basis of different evidences found from the ancient copper ore mining and smelting sites near the Aravalli Hills. Aravalli hills extend over a huge area from Gujarat in the Southwest to Delhi and also beyond in the North-east. Pre-Cambrian plate tectonics gave rise to the metallogenesis through hydrothermal deposition along the shear zones. The shear zones are rich in metal ores. The Northeastern zone is rich in copper. The central and Southwestern part also have oxide rich gossans cap. There is extensive deposition of copper ores in the form of chalcopyrite, malachite and azurite in the Aravalli belts which was a habitation area for Chalcolithic people of North Western India. Early mining and smelting areas have been identified by shallow gauged pits, deeper shaft and extensive slag heaps. Ahar (1800 to 1600 BCE) is the important ore bearing site in the area situated near Udaipur. It is located within the copper ore belt of Aravalli in Rajasthan. It has yielded copper tools with heaps of smelting slags. Metallurgical analysis shows that the percentage of silica, iron oxide and 0.67% to 0.91% copper oxides (Hegde 1969).

Agrawal (1982) pointed out that Harappan were not directly associated with mining and smelting of ores. Mining was done nearby areas of natural copper deposition and ingots were transported after smelting of copper from ores. This is more time and energy saving method instead of carrying heavy loads of copper. This hypotheses was proved with the evidences were found from Rajasthan, Ganeshwar and Jodhpur.

Melting furnace was made by locally available coarse clay. It is a composite structure with three separated curved parts containing luted tuyere, slag trapping hole and rest is plain one. These were made by moulds. The reconstructed furnace is small, 35 cm in height, 18 cm in diameter at the rim, 14 cm diameter at the mid level with capacity of 5390 cc. The copper ingots found from Lothal, Harappa and Mohenjo-Daro are shaped

like a bun and the Lothal ingots are 10 cm in diameter and 4 cm in height with weight 1438 gm.

The efficiency of early metal smiths is proved by the size of the ingots made in such a small furnace. They learned the technology of roasting ores to convert all copper minerals in copper oxides which contains 80% of copper. The roasted ores were crushed into fine powder is understood by the presence of ore-crushing pits near the ore bearing ridges. For removing gangue the crushed ores was allowed to flow down the incline plane. So the smelting sites were located near the bank of the hilly stream.

The smelting is done after mixing with crushed quartz, charcoal in the proportion of twice the weight of ore. Large quantities of locally available quartz are fund around the smelting sites. This mixture is charged into the furnace and smelted. More lumps of mixture and fuel were added until the optimum was reached. As the copper melts at 1083^0C the extracted liquid metals are collected at the bottom of the furnace due to high specific gravity of 8.89 below the molten slag of specific gravity 4. Then the slags were drained out and copper ingots were taken out after breaking of the furnace when it was cool (Agrawal 2000).

2.9 Technologies of copper and bronze of Harappan civilization:

The evidences for identifying metal processing sites include (1) fragments of ores, (2) Fragments of metal processing kiln, (3) Metal slags, (4) tools used for metal processing, such as crucibles, prills, moulds, anvils, stakes, hammers, chisel etc. and (5) finished and unfinished metal objects and smelting and melting ingots. Different stages of processing of copper and bronze of Harappan civilization are as follows:

2.9.1 Smelting of copper ores:

The early smelting of metal ores in a site has been identified by huge number of ores and metallurgical slag fragments present in the site. Direct evidences of smelting of copper ores is absent in the Harappan sites. However there is the evidence of some metal slags, which is the byproduct of melting rather than smelting. It may be that copper was imported in the form of ingots which have been recovered from Chanhu-daro, Lothal, Harappa and Mohenjo-Daro. These ingots were broken into pieces for further work (Kenoyer and Miller 1999).

2.9.2 Melting of copper:

Melting is necessary for casting copper objects. Sometimes remelting was done to purify the imported copper ingots to produce secondary and refined ingots. The archeological evidences of melting are crucible, kiln, slag and metal ingots. The systemic examination of these evidences gives a picture of meting process of copper on Indus Valley.

a. Crucibles:

The evidence of crucible which was used for melting of copper found at Mehrgarh (Period III) dated to 4000-3500 BCE. Perhaps it is the earliest evidence of smelting. Fragments of crucibles with slagging and copper prills have been discovered from surface survey and exploration of Harappa and Mohenjo-Daro. These crucibles were perhaps used for re-melting of crude metals for refining. Crucibles were made of thickly coated sand and clay with smooth inner surface and rough outer surface. There is evidence of multiple heating and slags are present at the edges (Kenoyer and Miller 1999).

b. Kiln:

Kilns were reported from Harappa, Lothal and Mohenjo-Daro. The interior portion is easily vitrified and blackened due to reduced firing. Experimental firing shows that vitrification of the walls of kiln ranges from 1000^0 to 1100^0C. The kiln of Harappa is 3ft 4inches in diameter and 3feet 8 inches to 5feet 3inches deep. The inner portion is covered with sand tempered mud plaster. It was partly constructed by mud bricks with vaulted roofs with five 'flue'. The sizes of two kilns of Mohenjo-Daro re similar in depth and diameter at the top and varied in the size of the base. It is 4ft. 3 in. deep, 3ft. 3in. in diameter at the top and 2ft. 10 in. and 3 ft. 2 in. diameter at the base. The circular kiln at Lothal is 6ft in diameter and 2ft 3 inches deep made of bricks covered with mud plaster. Circular furnace pit of Lothal is 1.5 m in diameter, 0.6 m deep with full of white ashes and slags. A small circular pit is found from Mohenjo-Daro and fragments of kiln wall embedded with copper prills from Harappa. There is no direct evidence of copper melting in the kiln but sometimes these kilns were found near the coppersmith's workshop (Kenoyer and Miller 1999).

c. Slag:

Copper slags were found from Lothal. Sometimes slags were attached with crucibles and kilns. In Mohenjo-Daro metal ores, identified near the habitation, implies control of production, control of technological knowledge, the status and power of metal smiths and sophistication of technological knowledge has been reflected in the bringing of ores from a distant places and smelting. The slags found from Harappa and Mohenjo-Daro are vitrified and clay based materials with copper prills, however metallurgical slags are limited. Perhaps these are the by-products of reprocessing of copper ingots or scraping of original smelting of cores (Kenoyer and Miller 1999).

2.9.3 Casting and Fabrication:

The production of Harappan metal is divided into two broad categories, casting and fabrication. Casting is done with molten metal and fabrication involved the shaping of the

metal when it is not molten. Different kinds of tools and implements are used for the casting and fabrication. Sometimes same tool types are used for both the works.

a. Casting:

Casting is the shaping of molten metal. It includes the production of secondary ingots to the casting of copper objects. Moulds, semi finished objects and finished objects are the evidences of casting. However, the best evidence of casting of metal is the presence of moulds. Moulds were made from different raw materials such as, stone, terracotta and sand. The broken moulds are the remnant of lost wax process. There is no vivid evidence of casting of metal from the Harappan phase. Stone moulds have been recovered from Lothal. The copper or bronze tools were made by open or bivalve casting. The famous metal figurines of human and animals can be attributed to lost model metal casting. Lost wax model employ several materials such as wax, resin, tar, coating of sandy clay. The lost wax moulds were made by coarser sandy clay that will not break under high temperature. The open mould is made up of sand and the mould used for lost wax process is sandy clay. The mixture of powdered sand, sugar and water was used for open mould or packed into a wooden box to make bivalve mould. A model is pressed into the sand mixture to produce mould in which molten metal is poured. This method is suitable for flat objects like celts, axes, adzes, knives or spears.

In lost wax method three dimensional features of the object is casted. The technique is complex in nature. The model of wax, resin, and tar in the form of the details of the object is coated with fine sandy clay. The crucible containing the metal is built and the casting is done in the covered mould in a kiln. Though there is no direct evidence of casting of metal objects but this method is common in South Asia. The Harappan casted metal objects have typical style which is not common outside the Indus region. So it can be presumed that the Harappan metal smiths were expert in casting method (Kenoyer and Miller 1999).

b. Fabrication:

Fabrication of metal objects includes shaping, cutting, joining and finishing of non-molten metal. The work can be done in hot or cold condition but below the molten state.

2.9.4 Shaping:

Shaping of metal objects was done by various methods like forging, drawing, spinning and turning. Forging is the shaping of metal by the force of a hammer. Forging is done by cycling of cold and hot hammering and annealing (pre-heating). Archaeological evidences of hammer, tool marks on the objects and sometimes metallographic analysis help to understand the forging method. This method was common in Harappan phase. Metal sheets were also manufactured by forging during Harappan times. There are archeological evidences of copper metal sheet from Harappa, Mohenjo-Daro, Lothal and Chanhu-Daro. Copper tubes found from the Harappan sites perhaps were produced from sheet metals. Although there were numbers of copper wires found from the Harappan sites, the detail method of manufacture is unknown due to poor preservation. The metal rods with pointed tips have been discovered from Lothal, Mundigak and Mehrgarh. These perhaps were used for drilling (Kenoyer and Miller 1999).

a. Cutting:

The Indus people cut objects from sheet metal with the help of chisels. The V-shaped or double edged chisels perhaps were used for cutting. The method of cutting was reconstructed with the help of chisel or saw marks. They cut a groove in the metal and snap the pieces into two (Kenoyer and Miller 1999).

b. Joining:

The joining method is not clear in Harappan metal objects. Rivets were used to attach handle to metal vessels. It is an example of cold joining. Sometimes molten copper is used to join handle with copper vessels. A large cooking vessel was discovered from Chanhu-daro, which has a joint at the carination (Kenoyer and Miller 1999).

c. Finishing:

Engraving was done to produce designs which have been found in figurines and numerous inscriptions on copper tablets and other metal objects. Stone burins or metal engravers were perhaps used for engraving. Polishing is evidenced on a few copper objects as the copper based objects are heavily corded. Polishing was done with ground and polished stone objects. Chemical wrapping was not present but mechanical wrapping with gold sheet over copper has been found from Harappa, Mohenjo-Daro, Alhadino (Kenoyer and Miller 1999).

It can be summarized from the above discussion that the production methods of Harappan copper based objects were primarily reconstructed from the features of the excavated metal objects and few manufacturing tools. Sometimes ethnographic study of metal technology has been used to learn about the process of manufacture of copper based objects. It also will be helpful to get information on study of Indus Valley metal tradition and the variation of the same with other contemporary traditions.

2.10 Copper and bronze beyond Indus valley civilization (Neolithic-Chalcolithic and Chalcolithic cultures):

2.10.1 Northern India (3000 BCE):

In the northern valleys of Indus system Gandhara Grave culture developed around 1700 to 200 BCE. At Gufkral from the Late Neolithic (Period IC) and Megalithic phase (Period II) evidences of copper objects including point, hair ring have been found

from the end of a kiln. Copper artifacts were found from Ghalgai cave, Katelei I, Loebnr I and Timargarha. The grave goods include different types of copper-bronze objects like pins with decorated tops, bronze model of horse (Allchin and Allchin 1996).

2.10.2. The Indo-Gangetic Divide, the Upper Ganga Valley and Doab:

The late Harappan culture of this area is represented by Ochre Coloured Pottery (OCP) culture, copper hoards and Black and Red Ware (BRW) phase.

a. Ochre Coloured pottery (OCP) culture (2650-1180 BCE):

In Central India and Deccan sometimes copper is associated with Ochre Coloured Pottery. Most of the sites are distributed in the doab namely Hastinapur, Achichhatra, Jhinjhana, Atranjikhera, lal Qila. Few copper artefacts were found from various sites. A spear head and harpoon made of copper were found from Saipai. The copper artefacts yielded from Lal Quila are pendants, bead, arrow head and a broken celt (Sing 2013).

b. The Copper Hoard culture (3500-2000 BCE):

Hoard of **c**opper implements have been identified in the Indo-Gangetic Divide (Punjab, Haryana, Northern Rajasthan), Ganga-Jamuna Doab, the Chota Nagpur hills and Odisha. The culture has two distinct groups, Doab and the eastern area of Chota Nagpur (Allchin and Allchin 1996). The first hoard consists of flat axes with semi circular cutting edges, spear heads with solid tang and barbed harpoon. The second hoard comprises of flat axes, long bar celts and shoulder axes. Most of the objects are made by casting method. This hoard reflects the copper using craft tradition, which was indigenous in origin. The hoards comprised of distinctive copper objects like bar celts, double-edged axes, anthropomorphic figures, hooked spear-heads, hatchets, antennaehilted Swords. Most of the objects are related to ritualistic objects rather than utilitarian.

During 3rd and 2nd millennium BCE Ganga valley became a distinct copper-manufacturing area and extends into the regions of Harayana, Gujarat, Madhya Pradesh,

the Deccan, Kerala and Tamilnadu (Sing 2013). However knowledge of alloying is not clear. Copper used throughout these are impure in nature with traces of tin, lead and arsenic. Copper beads were found from Black and Red Ware level of Atranjikhera.

2.10.3 Central India:

Chalcolithic culture of central India is concentrated in the valleys of the river Chambal and Narmada and their tributaries.

a. Kayatha Culture (2000-1800 BCE);

The earliest Chalcolithic culture of the area is Kayatha dated 2000 to 1800 B.C. The Kayatha people were well acquainted with copper-bronze. Copper artifacts include axes and bangles (Rami Reddy 1991). Two copper axes and twenty nine copper bangles were found in a pot. These were made by casting technology (Sankalia 1974). Kayatha people used bronze objects. Copper celts are generally moulded. Bronze ornaments include bangles and necklaces (Agrawal 2000).

b. Malwa Culture (2400-1500 BCE):

Malwa culture was developed to the east of the Banas valley and the Aravalli hills around 2400 to 1500 BCE. Important sites of Malwa culture are Navdatoli, Maheswar, Nagda and Eran. Copper artifacts are less than stone stools probably due to the scarcity of raw material (Sing 2013). Assemblage of copper artifacts includes flat axes, arrow head, spear head, chisel and blades. Copper ornaments include rings, beads, bangles, chisels, nail parers and spearhead or sword. They also used rings and bangles of copper. Tin was also used as an alloying material up to 3%. The technology was cold work and annealing.

2.10.4. Western India:

Two important cultures are Ganeswar Jodhpura culture of north-eastern Rajasthan, Banas culture and Ahar culture of south-east Rajasthan.

a. Ganeswar Jodhpura culture (2800 to 2700 BCE):

The excavation of Ganeswar yielded a good number of copper objects. These comprise 400 arrow heads, 50 fish hooks, 60 flat axes, spear heads, awls rings, bangles, spear heads, chisels, balls and celts (Agrawala 1979). This site is unique in the sense that about 2000 copper objects were collected in different seasons of excavations. Some of these artifacts are made from pure copper and others show the alloy with 3 to 12% of tin. Fragmentary copper objects were found from Jodhpura Period I, dated to 2800-2700 BCE. Fishhooks are simple and un-barbed type.

Throughout different phases of protohistoric culture into the present days this area of Rajasthan and adjacent area of Haryana was widely explored for copper by early and present day people both. This area is one of the earliest metallurgical areas together with Sind, Punjab, the Ganga-Yamuna Doab, Central India and Gujarat. The Ganeshwar Jodhpura Cultural Complex have similarities in material culture, production of copper tools, and geographic proximity to copper mines and indigenous development that sustains a larger regional economic need for copper products.

Ganeshwar is located near the rich copper sources of Sikar-Jhunu jhunu area of the Khetri region of Rajasthan. Many ancient copper working localities have been identified in Khetri region. Spectometric analysis suggests that this source of copper also was used in the sites during this period in Haryana, Rajasthan, Gujarat, Madhya Pradesh and Deccan. It also is believed that copper objects were supplied to the Harappan people from this area (Allchin and Allchin 1996).

b. Ahar Culture (2580-1500 BCE):

In the Southeast Rajasthan Ahar culture developed. Important sites are Ahar, Balathal and Gilund. Flat Copper axes, knife blades, copper sheets, bangles and rings and a quantity of slag have been found in Ahar culture. The axes were casted in mould. Arsenic and lead were used for copper alloying. Since lithic tools were not used for household purpose along with the copper, Sankalia preferred the term Copper Age for Ahar culture. The traditional name of the site was “Tambavati”, “A copper making or smelting city” or a city having copper (Sankalia 1974).

Copper objects found from the sites are flat axes, choppers, knives, razors, chisels and tanged arrowheads. Metal objects found from Chalcolithic level of Balathal are six petalled flower-like objects, appoint, an ear-stud and razor blade (Agrawal 2000).

The growth of two metal craft specialization in south east and north east Rajasthan played a vital role in the development of metallurgical tradition of Indus valley civilization. The area is famous for a number of sources of metals. Zawar is famous for zinc, Rajpur Dariba is famous for copper and Aguncha is famous for lead. The ore source was the nearby Aravalli hills and they have close contact with the Ganeshwar area prove the spread of mature Indus civilization to the Rajasthan (Allchin and Allchin 1996).

2.10.5 Deccan:

a. Jorwe culture (1500-700 BCE):

The Chalcolithic period of Western Maharashtra is represented by Jorwe culture. Copper was used in a large scale in this culture. Flat copper axes were excavated from Nevasa, Jorwe and Chandoli sites. An antennae- hilted dagger and fish hooks were noticed from Chandoli. Copper beads and bangles were common ornaments and also used as grave goods as found at Nevasa and Chandoli (Rami Reddy 1991).

A number of bronze items were discovered from Daimabad in Maharashtra. The objects are not utilitarian made by solid casting method. One bronze statue is a man standing on a two wheeled chariot which is driven by two yoked oxen a water buffalo. Other statues are water buffalo, an elephant and a rhinoceros each standing on wheel. Copper was scarce in Inamgaon (Singh 2013). However copper was used to make axes, chisels, knives, fish hooks, beads and bangles in Inamgaon. Metal also played an important role in burials as copper objects are found in urns in Maharashtra. In the graves of Chandoli and Nevasa some children were buried with copper necklaces and other were associated with pots.

Malwa culture and Jorwe culture was not directly associated with the Harappan culture. Pre Harappan Chalcolithic culture in Sind, Baluchisthan and Rajasthan emerged with the growth of urban civilization in Harappa. However the Chalcolithic culture in Central and Western India continued through 1200 BCE, and Jorwe culture continued till 700 BCE. There was about four to six centuries gap between the Chalcolithic and Early historic cultures in central and western India and in Eastern India the Chalcolithic phase immediately merged with the Iron Age. The Chalcolithic people were usually rural and used to live near river banks. Their houses were made of mud bricks. Stone built houses are found from Ahar. Ahar people practiced metallurgy from the beginning.

2.10.6 South India (2300-1500 BCE):

The introduction of metallurgy with the evidence of copper-bronze objects in this region was found from Brahmagiri, Sanganakallu, Takkalakota and Hallur. A copper chisel and fragments of a copper bowl was found from Piklihal Phase II. A copper axe was found from Tekkalakota Phase I. Copper spiral, a piece of copper wire, a copper ring, a copper nailhead was found from Phase II of Tekkalakota. Double-edged axes and fish hooks were found from the deposit of phase I, period I in Hallur (Sankalia 1974). From the phase II miniature of copper axes and fish hooks were discovered. From Brahmagiri Phase IB a circular rod and a flat axe were yielded. A fragment of copper rod

was found in Neo- Chalcolithic level of Maski Period I (Rami Reddy 1991).Copper or bronze objects including twisted wire and pendant were found from period IIB (2300-2000 BCE) and few copper or bronze objects from Period IV (post 2000 BCE) were found from the site Watgal (Singh 2013).

2.10.7 Middle Ganga Valley (1300-700BCE):

Copper objects found from the site Narhan are ring and fish hook. The alloy was low tin bronze. Cold working, annealing and casting were practiced by the metal workers. Copper beads were found from Imlidih Period II (Sing 2013).

The Chalcolithic cultures in India are non-urban and non-Harappan in nature. This period is characterized by use of both copper and stone. Pottery was used as domestic utensils for cooking, eating and drinking. The economy was not much different from Neolithic period. The significant changes are marked by increase in the number of settlements, introduction of copper-bronze technology for the manufacture of tools, weapons and ornaments, improvement in architecture, introduction of diversified pottery types and prolific decoration of vessels (Misra 2001). They cultivated cereals such as barley, wheat and lentils in Western India and rice in Southern and Eastern India. The food was also supplemented by non vegetarian foods like animal protein and fish. Cattles were also domesticated. The Central and Western Indian Chalcolithic people did not practice cultivation in extensive way. Different types of craft developed there. Besides tools coppersmiths made beads from semi precious stones, such as carnelian, steatite and quartz crystal. Other crafts include terracotta, ivory work, pottery and textiles. Evidence of flux is found. These cultures were developed during 2nd millennium BC and eventually replaced by iron using culture. These cultures were determined by smaller ecological units and carry distinct regional identity (Agrawal 2000).

2.10.8. Eastern India (2000-800 BCE):

A number of village farming communities developed after the fragmentation of Harappan Civilization. In Eastern India the Chalcolithic culture is called Neolithic-Chalcolithic culture

a. Bihar:

The excavated Chalcolithic sites in North Bihar are Panr in Samastipur District, Chechar and Ramchaura in Vaishali District, Chirand in Saran District. In South Bihar the chalcolithic sites are Oriup in Bhaglapura District, Maner in Patna District, Sonepur and Taradih in Gaya District and Senuwar in Rohtas District. Copper objects noticed from Chirand IB belong to Neolithic-Chalcolithic phase and fragmented copper bangles, bands, wires points and beads were noticed in Period II, the terminal phase of Chalcolithic period at Chirand (Verma 2007). At Sonepur IA a solitary piece of copper was discovered. Copper bar and miniature of a bell were found from Chacolithic Phase Period II (Sinha and Verma 1970). The copper assemblage of Taradih Period II includes a fishing hook, an arrow head, wires, household objects, ornaments like bangles, earrings and finger rings (Prasad 1981). The chalcolithic copper remains of Senuwar Period IB includes points, fish hooks, an arrowhead, a needle, two nails, wires, rods, a ring and bangles (Singh 2004). Period II of Senuwar is Chalcolithic. Copper beads and socketed arrow heads with perforation were noticed from Chalcolithic phase of Khairadih. Oriup Period I is Chalcolithic and has yielded a copper bangle.

b. Odisha:

Odisha has a rich Chalcolithic cultural phase. Double axe made of copper was noticed from the site Baghra Pidha in Mayurbhanj District. It was without precise context. The excavation of Sankarjang (Yule *et al*. 1990) in Central Odisha has the evidences of metal bangles. The radiocarbon date of Sankarjang is 2590± 60 BP. Golbai Sasan in coastal Odisha was excavated by Archaeological Survey of India (Sinha 2000). Golbai Period IIa was Osteo-Chalcolithic in nature, dated around 2100 and1100 BCE. Copper chisel, fish hook, rings and bangles were excavated together with good number of

crucibles and furnace from Period IIa. These imply knowledge of metallurgy. No metal object was found from Gopalpur (Kar *et al.* 1998, 2000). Copper objects in the form of bangle, ring, and fish hooks have also been found from Khameswaripali Period I and II in Western Odisha (Behra 2001).

The metal objects found from Kuanr in Keonjhar district of Odisha include a number of metal objects such as broken and complete bangles, rings and pendants. The metal objects have green patina. During trial digging (2009-2010) a complete necklace was found made of carnelian beads and brass pendants were found. The bangles have different types of design both geometric and natural. Archaeo-metallurgical analysis of some of the bangles suggests that these are made of old type brass, alloy of Copper (54%), Zinc (33%), Tin (8.5%) and other impurities (Ray *et a.l* 2000). The Neolithic and Chalcolithic culture emerged in the complex society of Odisha (Sahoo and Basa 2013)

c. Jharkhand:

According to Gordon there were two industrial areas for copper metallurgy during the Chalcolithic period; one in the Ganga-Yamuna Doab and the other around the region of Ranchi Plateau. A number of Chalcolithic sites were excavated by S. C. Roy in Bedwa, Bandua, Kandesa, Belua, Chakradharpur, Digi, Murud etc. The sites together are known as Asura sites, of which 20 villages around the Khunti yelded copper implements and ornaments. Saradakal had yielded copper hooks, rods and coins along with iron implements. Bargunda yielded evidence for ancient technology of copper production. Musabani, Chirudih, Dugri, Chota Jamjora, Dudra reveal the evidence of ancient mining of Copper ores in Singbhum. Evidence of chalcopyrite and magnetite around the Megalithic sites prove the parallel tradition of copper and iron metallurgy at Rola, Jabra Road, Silwar valley and Chitpur.

The tradition of Copper Hoard culture also was found in Jharkhand. Copper bar celts, a single copper tool have been recovered from Hami and shouldered flat axes from Pachamba in Giridih. Bargunda yielded of copper bars and ornaments like ring, bangles and others. Copper axes also were found from Bartola in Ranchi District. Copper

implements including copper axes and bangles were found from Chechari and Besia. Copper bars, celts, ingots, and flat axes are reported from Namkum, Bero, Dargama etc. in the District of Ranchi. Copper celts and axes from Godda and Palamau; copper axes from Karharbari, Gola; and copper battle axe are reported from Kathurba. Bargunda is famous for production of copper implements and the other sites were well connected with the copper belt of Dhalbhum (Das 2013).

c. West Bengal:

The Chalcolithic culture in West Bengal is clearly identified as a number of sites yielded evidences of copper. Bharatpur Period I in Damodar valley yielded copper objects together with black-and-red pottery. Mahisdal (IAR 1963-64) in Period I in the Kopai valley yielded evidence of a celt made of copper. Copper spiral bangles, rings, beads and fish hooks were discovered from Mangolkot period I in Ajay valley. Few copper objects were found from Baneswardanga Period I and II. A copper ring was found from Bahiri Period I (Chakrabarti and Hassan 1982). Dihar in the bank of the Dwarakeshar is an iron free chalcolithic site (Chattopadhyay *et al.* 2010). Copper bangles and wires were discovered. The bangle is of bronze, an alloy of copper and of tin (9%). Copper bangles were also discovered from Pandurajar Dhibi Period II (Das Gupta 1964). Few copper objects were noticed from Nanoor. In West Bengal Copper perhaps was extracted from Malachite-azurite, though the source is unknown. Metallurgical analysis shows that no relation with the copper source neither in Rajasthan nor in Singbhum is established (Agarwal 1971).

It may be summarized from the above discussion that bronze was not common in Chalcolithic cultures beyond the Indus valley civilization. Copper was prevalent in these cultures and each of the culture was flourished in limited geographical boundaries. These are local in origin.

2.11 Sources of copper in Chalcolithic cultures of India:

Copper was extracted both from shallow pits and deep mines. Copper was extracted by firing into shallow pits as per the evidences found from Chhotanagpur plateau and adjacent Bihar, West Bengal and Odisha.

All the deep mines opening into galleries provided with one or one and half meter ventilation holes at regular intervals. Narrow tunnels of Chalcolithic ore veins are present at different levels. There are the evidences of treatment with fire at the mine walls to widen the rock join which facilitated extraction of metals. These ore bearing rocks are roasted, crushed, concentrated and smelted. Different processes of ore dressing are identified near the mouth of the mines in the form of waste metals. Smelting sites were identified by huge slag heaps and remains of broken crucible and tuyeres. The remains of furnace, broken at the bottom, shows that perhaps they had no way to collect the molten metal. Therefore it was collected after breaking the furnace when it was cooled down (Agrawal 2000).

Aravalli Hills possibly supplied copper to the Chalcolithic communities of India and Ahar is the copper smelting centers of Chalcolithic period. But one has to decide critically that either of the two; that whether this hypotheses is applicable for the Chalcolithic culture of other parts of India, mainly Southern and Eastern India or whether they utilized the local copper ores. There are rich sources of copper ores in Southern and Eastern India (Agrawal 2000).

2.12 Technologies of Chalcolithic metallurgy in India:

Chalcolithic culture is divided into smaller ecological groups. The culture is represented by Banas culture in Southeastern Rajasthan, Kayatha culture in Malwa region, OCP culture in mid-Ganga Valley. The copper technology is not clear in Ahar. Copper was used to make axes, blade, bangle and one sheet. The axes have blow holes and the evidence of hard working is absent. The axes of Kayatha culture were caste in a

mould. In Malwa culture mid-ribbed sword was cats in a mould and other metal objects were shaped by hammering. Cold work and annealing were also applied repeatedly. For alloy tin was used up to 3% and lead about 2% with copper. Arsenical copper is absent except one. Different copper objects were excavated from Jorwe culture of Deccan plateau. Copper was used to make axes, chisels, knives, fish hooks, beads and bangles in Jorwe Chalcolithic. A boat shaped kiln made of clay and copper ores were found from Inamgaon. This evidence suggests that copper ores were smelted from ores and were fashioned locally. Copper was extracted from the chalcopyrite (Agrawal 2000).

No detail study has been done on the metal technology of Chalcolithic culture of Eastern India. The copper artifacts found are few. There is an attempt to reconstruct the metal technology of the Chalcolithic of Eastern India in the present study.

2.13 Copper and bronze in Iron Age (1300 -750 BCE):

Copper was also common in Iron Age period and frequently associated with the megalithic burials in South India. Copper artifacts were found in middle and lower Ganga valley, Deccan plateau. Copper beads and bangles were found in Black and Red ware (BRW) culture. In South India Copper and bronze objects were found from different Iron Age sites. In north India copper was less common but present in the form of arrow head, pins and rods. Copper and bronze objects were casted in mould and sometimes hammered into shape (Singh 2013). In arid and semi arid regions copper was too brittle for clearing of forest. There is scarcity of copper and availability of iron ores in Chotanagpur area and central India. Copper and bronze were precious metal which is used by the rich and influential members of the society.

After that the use of iron for making tools widened up and use of copper was limited for making of coins in Early Historic periods and onwards.

2.14 Evidences of brass from sites around the world with focus on eastern India:

The alloying of zinc with copper increases the strength and hardness. Archaeo-metallurgists reconstructed two methods of production of early brass i.e. cementation process and distillation process with zinc. In cementation process the percentage of zinc is below 28% and the brass containing more than 28% of zinc was produced after the invention of the knowledge of extraction of zinc from the ore and was produced by distillation process. Therefore it may be said that the method of cementation is early in origin.

2.14.1. China:

Brass was perhaps produced first in China as there are archeological evidences of few scattered pieces. The history of brass and zinc in China is divided into four stages: accidental brass, imported brass, cementation brass and speltering brass (Zhou 2012). The earliest evidences of brass were found from the discovery at the Jiangzhai site of the Yangshao culture I (4700-4000 BCE), in Xi'an, Shaanxi province and Late Yangshao culture (around 3000 BCE) in Weinan, Shaanxi province (Han and Ke 2007: 182). A thin piece from the former site was analyzed and found to contain 25.6% zinc, while a tube contained 32% zinc (Han and Ke 1988). A long hair pin of the Late Yangsho culture was analyzed and the result shows that the alloy contained 27 to 32% zinc with copper. A brass awl was found at the Shanlihe site of the Longshan culture (2300-1800 BCE) in Jiaoxian, Shandong province with 20.2 to 26.4% zinc. There are lots of controversies regarding the date and the analysis of the brass objects. Scholars opined that such brasses could have been produced by smelting mixed copper ores and zinc ores in rudimentary conditions. Scholars believe that the brass was not the product of intentional smelting rather it was accidental. The metallurgical analysis of Wang and Fan suggests that it was

probably produced by solid state reduction process. They also argued that China did not begin to smelt zinc before the Wanli period (AD 1573-1620) of the Ming Dynasty.

China started to use zinc and brass from late 3rd century BC during the Han Dynasty. According to Craddock and Zhou zinc was introduced in China during Buddhist times around 2000 years ago. Brass produced by cementation method was imported via Silak road from Persia and India during the Eastern Han period (AD 25-220), at the time of introduction of Buddhism and it continued in to 9th century AD. It was with the high concentration of zinc going up to about 29% and most of the brass artifacts were imported. This imported brass is called '*toushi*'. The *toushi* were made by cementation process with copper and zinc. Brass coins were produced in large scale from the middle Ming period. It was found that there was an increase in the percentage of zinc is by 20% to 28% in brass coins from Zhao Dynasty (3rd Century BC) to the Ch'ing Dynasty of late 19th century in brass coins. These were result of analysis (Bowmann *et al.* 1989).

Brass was not common commodity in China until 3rd Century AD. Oxidic zinc ores was not common until AD 907 to 960. It was introduced by alchemist and then spread to the commoners. The Ming (AD 1368-1644) and Qing (AD 1644-1911) dynasties have elaborate evidence of brass artifacts. Brass was used for coins, figures, architectural fittings, astronomical instruments and to make patkong, an alloy of copper, nickel and zinc. Brass was also exported into different parts of the world. The copper based alloy of Song to Qing dynasties (AD 1000-1900) is termed as 'Later Chinese bronzes'. There are evidence of domestic vessels used in daily life for functional and decorative purpose i.e. wash-basins, incense burners, flower vases and mirrors. Ceremonial vessels, in the forms of incense burners and vases, were used for tombs, temples. Buddhist and Daoist statues were used for worship in temple. Burial items were made in animal and human forms (Kerr 1990). These were not traditional bronze of copper-tin alloy.

The percentage of zinc increased from the Ming period and is better termed as brass. The brass of Ming dynasties was restricted in their use. These were used in temple

and as luxurious items in palaces and were made for religious and ritualistic purposes. The zinc level increased from 20% to 30%. Zinc as a minting material for coins was under the control of the state. China exported zinc to Europe In 17th century.

2.14.2 South-West Asia and Eurasia:

Copper zinc alloy was first developed in Southwest Asia as early as 3000 BCE and continued into the Greco-Roman period. Various types of brass objects including pins, ornaments and knife found from different layers of Thermi in Lesbos belong to early 3000 BCE to mid 3000 BCE. Metallurgical analysis shows that out of eight objects four have the concentration of zinc (8.5 to 16.9%) and rest have low percentage of zinc. Varieties of knife, bowls, blade rivet, dagger, helm made of brass were discovered from Kish, Girsu and Ur of Southern Iraq belong to mid-late 3000 BCE. Out of eight implements three have high percentage of zinc (10 to 14.3%). The third group included Ergeni of Kalmykia, Telebi of East Georgia, Nuli and Akhchia of North Gorgia, Namazga and Altyn depe in South Turkmenistan, Dalverzin of South Uzbekistan. Quantities of knives, hooks, blades, discoid pins, needles, seal, rings, twisted tube found from these sites were analyzed and the result shows that out of twelve objects, six have high percentage of zinc (8%-25%). These artifacts belonged to the mid 3000 BCE to early 2000 BCE. The fourth group includes the sites of late 3000 BCE to early 2000 BCE. The sites are Umm an-Nar in UAE, Tepe Yahya in Sotheast Iran which yielded the evidences of dagger, bracelet, ribbon and fragments. According to the metal analysis all the specimens have high zinc concentration (8.6-17%). The sites under fifth group are Ugarit in Northwest Syria, Nuzi (II) in Northeast Iraq and have yielded three rings and one statue of brass of mid 2000 BCE to 1350 BCE. These have high concentration of zinc (12- 14.4%). The sites under sixth group are Khachbulag in West Azerbaijan, Sarytepe in Northwest Azerbaijan , Luristan Bronze in Western Iran, Nimrud in Northern Iraq, Cavustepe in Northeast Anatolia, Gordion (MM) in Central Anatolia (Young 1981) belong to the early 1000 BCE to 800 BCE. The brass implements are bracelet, arrowhead, figurine, pin head, brooch, bowl, fibulae. Metallurgical analysis prove that

out of thirteen specimens eleven hade high concentration of zinc (8- 12%) (Thronton 2007). The others group includes Amorgos in Cyclades (Renfrew 1967) which has a dagger belonging to mid-3rd mill. BCE (Zn-5.1%), Sanlihe in East China (Sun and Han 1983-85) has an awl of mid/late 3rd mill. BCE (Zn-23.4%), Beth Shan in North Israel (Oren 1971) has an axe early 2nd millennium BCE (Zn-6.5%), Lothal in West Gujrat (Rao 1985) and Atrajikhera in North India (Gaur 1983) also have high percentage of zinc.

There was no zinc or brass in Egypt before Roman period. Brasses in Africa came through the European and Arab trade and a common term, *nahas*, is used for copper, bronze and brass. This trade also introduced brass in Niger, Guinea regions upto the central Sudan. Palestine bronze has sometimes low zinc content. Cyprus was an important brass manufacturing centre in the Roman period. Natural *calamine* or *cadmeia* was found in Cyprus. However the natural calamine of Macedonia and Spain was of inferior quality. Brass was not common in Greece until the Augustean Age. Manufacturing of brass on a large scale began in the West in 1st century BCE. Another important centre of brass production was Germania, which flourished between 150 and 300 AD. In Persia brass production started in the 6th century AD. Zinc was introduced to Europe in the 18th Century AD by Portuguese and Dutch traders.

2.14.3 India:

Brass and zinc were also common in Ancient India. According to Vijaya Deshpande metallurgy of zinc as well as brass developed much earlier in India and China than in Europe (Deshpande 1996). Production of brass with considerable amount of zinc possibly appeared first in Indian subcontinent (Biswas 1993). Though typical brass is absent in Harappa, but trace of zinc was found in late Harappan site like Lothal (2200-1500 BCE) yielded the oxidized artifact with 70.7% of copper and 6.04% zinc, perhaps produced through the oxidation of zinc bearing copper ore or by cementation process. The raw material probably was collected from Ahar-Zawar area. The Harappan site Rosdi

in Gujarat has the evidences of chisel, celt, rod and bangle made of brass with 1.54% zinc. 10.68% zinc was present is objects found in Dwarka (1500 BCE).

Atranjikhera of PGW era (1200-600 BCE) yielded copper based alloy of 6.28-16.20% zinc with lead (Pb) and tin (Sn). High zinc brass containing more than 28% of zinc came from Taxila dated to 4^{th} century BCE contains 34.34% Zinc. Brass articles were excavated from ancient stupas dated to 1^{st} Century BC. Brass coins were also common in ancient India. Punch marked coins were found from Ayodhya (1^{st} Century BC), die-struck coins in Pre-Gupta and Gupta period. High percentage of zinc was found in the brass yielded during 2^{nd} Century BCE to 11^{th} Century AD. The percentages of zinc vary from 7.60 to 30.40. Different brass icons of medieval period (1350-1752 AD) were analyzed. Metallurgical analysis of these brass icons show the percentage of zinc vary from 18.5 to 39.9 (Biswas 1993). The traces of iron and sulphur indicated that chalcopyrite or sphalerite-galena perhaps used as raw material of Ahar-zawar area. Harappan people earlier used tin and arsenic alloy but due to scarcity of raw material they forced to use zinc from the mines of Rajasthan.

Zawar is the only known ancient zinc metallurgical site in India in the Aravalli hills in Rajasthan (Craddock *et al.* 1985). There is evidence of ancient mining. Furnaces for smelting zinc and retorts were found. Rajpura-Dariba, Rampura-Agucha, Zwar Mala are renowned mining sites of the area. The mound of lead-zinc at Rajpura-Dariba in Southern Rajasthan dated to the second half of 2^{nd} millennium BCE (Craddock *et al.* 1989). Mining of zinc ore in Zawarmala is dated to 3^{rd}-4^{th} century BC. Evidences suggest that smelting ranged from 4^{th} century BC to 9^{th} century and carried out to the Early Historic and medieval period. Due to several reasons the mines was abandoned around 1812 AD. Zawar was also mentioned in our ancient literatures like *Rasaratnakar*, *Rasaratna-samuchchaya*, *Ain-i-Akbari by Abul Fazl and* Kautilya's *Arthasastra*.

Zawar may be considered as the earliest centre of high temperature distillation process of zinc in the world from where diffused to the other areas (Craddock 1987). The high percentage of the zinc was extracted through the distillation process of the zinc from the ore. This technology perhaps developed in China later. However there is evidence of

high percentage of zinc in China from 4th millennium BC, but these were exported because so far there is no evidences of making of the brass in the country. It may be hypothesized from the above discussion that India perhaps supplied the brass to China as because no other country was acquired the technology of extraction of zinc from the ore through distillation process at that time period. Moreover brass made by cementation process appeared in China from the period of introduction of Buddhism. Perhaps with Buddhism brass was also imported in China via the Silk Road from the Western regions, mainly Persia and during Han period around AD 25-220 (Zhou 2000).

In eastern India the earliest evidence of brass found from the Neo-Chalcolithic site Kuanr in Keonjhar district of Odisha (Ray *et al.* 2000). The Chalcolithic culture in eastern India dated to 2nd millennium BCE (Possehl 1988). The evidences of brass excavated from the site Kuanr in Keonjhar district of Odisha has immense importance in understanding of the indigenous development of metallurgy of brass in eastern part of India. Archaeo-metallurgical analysis of some brass bangles of the site suggests that these were very old type of brass, alloy of copper, zinc and tin. The alloy contains 33% of zinc with 54% of copper and a small amount of tin (8.5%) and other impurities. Impurities of lead and iron indicate that zinc were extracted from local ores like chalcopyrite and were produced by lost wax method of casting. Tin was not common in Eastern India and people invented zinc as an easily available raw material and suitable for casting.

Brass bangles of Senuwar dated to Kushan Period. The metallurgical analysis shows that the brass of Senuwar composed of 64.32% copper and 35.52% zinc (Singh 2004). Three pieces of brass bangles were discovered from Chirand dated around CE 700-1200 (Verma 2007).

Brass chariots replaced the wooden chariots during the 19th Century. The earliest brass chariots were reported from the village Bankati in Bardhaman district, Ramgarh in west Midnapur (9.10 m in height). Brass sheets were decorated by repousse technique with the images of religious and sometimes social character. Sometimes the chariots resembled with nine faced Bengal temple as the evidence found from Birnagar in Nadia district (Chattopadhyay and Sengupta 2011).

There are also a number of indigenous communities like Sithulias, Ghantara who practice lost wax process of metal casting in the Eastern India. They also provide ethnographic parallels with the Chalcolithic culture of Eastern India.

2.15 Technology of ancient brass working:

History of brass is associated with the geology of zinc. Zinc is soft bluish metal of transition element having a density of 7.14 gm/ml with a close packed hexagonal structure. The zinc is also considered as 'spirit of tin'. It was derived from the term 'Zincke' or 'Zacke' which indicates the ores for its sharp needle like form of the local calamine. Zinc is called by different name in different regions of the world. The Persian term used for zinc ores and zinc oxides is '*tutiya*'. The Sanskrit word '*yasada*' means that which gives *yasa* or fame. The connection is clear as zinc was known to produce the famous gold-like yellow alloy of brass. It became *jast* and *dasta* in several Indian languages. Paracelsus (1616 AD) is generally credited to give the name 'zinc' to the metal which was exported in large quantity from India to the West starting as late as 17th Century AD. In China it is known as *'totamu'* or '*tutenga*'. The name '*Tutenga*' perhaps was originated from the word '*Tuthanaga*' which is the name of zinc in South Indian language. Etymological evidence suggests the transmission of ideas regarding the zinc between two countries. The facts also indicate that zinc was smelted earlier in India than China. '*Tutta*' is used for colour of peacock's neck, for copper sulphate. The Arabs used the term '*tutiya*' without any discrimination of these. It was also mentioned as the 'spirit of tutiya' meaning 'brother of silver'. In sanskrit '*naga*' is used for lead, zinc and tin. Tantra around 1100 also mentioned zinc, which was seventh metal known to Hindus (Forbes 1950).

The term '*laiton*' was used for brass in Romanic language and derived from the Italian '*latta*' meaning sheet brass. In Buddhist literature it was mentioned as '*tutty*'. Chinese used the term '*toushi*' for both calamine and brass. The Greeks used the term '*cadmeia*' for both the natural and artificial products. Cadmia, as the general name for

zinc ores was well known source of this across the sea. Roman traders wrote about Indian brass during the 1st Century AD. The Greek term '*orichalkos*' (mountain copper) was used for brass. The Latin '*aurichalcum*' (Golden copper) is a corruption of '*orichalkos*' in Greek which denotes brass from the Christian era. There is also an opinion that the name '*cadmia*' derived from Calamina, a port at the mouth of the River Indus. However Ball suggested that it was Calliana near Bombay that exported brass in different parts of the world. The leaded brass in ancient India was called '*kakatundi*'. In Chinese language brass is also called '*thou-shih*'. There are some doubtful terms regarding brass such as '*chlkolibanon*' in Greek, '*nehoseth*' in Hebrew, '*htm*' in Egyptian, '*brinj*' in Turkish language (Forbes 1950).

Zinc is found in association with ores of lead, silver, copper, antimony and arsenic. Sometimes it is found as complex ores. Two important zinc ores known to the early metallurgists are *true calamine* and *hemimorphite* that occur in the surface of the earth. The term *calamine* is used for both of them. Zinc oxides are found together with contamination of clay. Presence of iron oxides or calcites gives its earthy appearance. Zinc deposits are found in America, England, Germany, Italy, Spain, Sweden, Norway, France, Belgium, Carinthia, Styria and Tirol. Outside Europe it occurs in India, China, Japan, Algeria, Nigeria, Rhodesia, Transvaal and many other places of the world. Egypt has no deposition of zinc ores (Forbes 1950: 274).

Scholars have argued that the production of copper-zinc alloys is more complicated than the creation of other copper based alloys due to the volatility of zinc above 906 °C, which is below the temperature at which zinc will reduce from its ores (Craddock 1998). The melting point of zinc is low (419^0C) and molten zinc boils at 918^0C before being smelted from the ore at 1000^0C. During the reduction of calamine the formed zinc will immediately distill and condense against the roof of the furnace as solid zinc crystal. This process is known as distillation. The sublimation of zinc was possible in closed crucibles otherwise it will re-oxidize soon in the form of zinc oxide (Forbes 1950).

No zinc could be produced below 950^0C. So reduction of zinc oxide around 1000^0C is important. Zinc is obtained in the vapour form at this temperature before its

boiling point 918^{0}C. The zinc formed would be reoxidised in presence of oxygen. So it is done in air-tight crucibles. Controlling of temperature is very important for making brass. Early metal artisans acquired the knowledge of brass technology and control of fire for attaining the required temperature. This technology of continued through the Middle Ages and the Renaissance to the mid-19th century. There is also the evidence of collection of zinc from the furnace flues at Ramensberg, Germany in the 17th and 18th Century (Craddock 1998).

The reduction of zinc from calamine with charcoal will be possible if the furnace is constructed in the form of retorts which must be connected with air free receiving vessel. There is an intimate connection of production of zinc with evolution of distillation technology. Zinc distillation requires evolved technology and apparatus which developed later. So there is a difference of more than 2500 years between the manufacture of copper-zinc alloy, brass and its metallic constituent zinc (Forbes 1950).

The crucial ingredient for alloying of copper-zinc in both cementation and distillation process is zinc oxide, which can be found in its natural state as the ore smithsonite (ZnCO3) or sublimated and oxidized by intentionally roasting zinc-sulphide ores such as sphalerite. In most cases, zinc oxide would be found by the metalworker as a white powder clinging to the inner lining of the furnace walls or in the flue. Thus two types of the zinc were used during earlier times i.e. 'earthy' natural calamine and artificially produced zinc oxides or '*cadmia'*. Zinc was primary used for alloying with copper to produce brass in the past. These archeological evidences prove that brass emerged earlier before the regular production of metallic zinc (Thronton 2007).

The next stage is to create a copper-zinc alloy by separating the zinc ores from the oxides and adding it to copper through sublimation before it deoxidizes. There are two basic technologies of copper-zinc alloys: Cementation method and mixed ore smelting process. The accidental smelting of mixed ores or high zinc copper ores produces copper metals with 6-7% of zinc. Thus it is not an intentional alloy. The earliest evidences of brass artifacts in the form of ornaments and jewellery have been found in the near and Middle East dated to Bronze Age and early Iron Age probably produced by zinc-rich

copper ores. Manufacturing of brass by cementation process started from the mid 1st Century BCE. The earlier method is known as the cementation process of zinc. In this method finely ground calamine (oxidic zinc ores) and metallic copper were mixed with powdered charcoal as a reducing agent and heated and react in a closed crucible heated about 906^0C (Bayley 1998). During Roman times temperature ranged from 1000^0C to 1100^0C. The vapourised zinc produced by heating is absorbed by copper giving it the golden yellow coloured brass. It is a low zinc brass. The advantage of the technology is that at the temperature of 800^0C, below the melting point of zinc, will diffuse into the copper to form brass. The fusion of zinc with copper increases the strength, hardness and toughness of copper. Brass produced by cementation process contains 20% to 28% of zinc. The brass produced is of very poor quality and the percentage of zinc could not be easily controlled (Thronton 2007).

The other method was experimented to produce copper-zinc alloys with up to 34% of zinc by mixing chemically pure zinc oxides (Zno) and cuprous oxide (Cu_2O) in 1:1 proportion in a graphite crucible. This method also could produce alloy of 18% of zinc by smelting the mixture of natural malanchite [Cu_2 $(OH)_2$ $CO_{3]}$ and leaded smithsonite (Sun and Han 1863).

The cementation is the direct production of brass and also meant that zinc was not recognized as a separate metal. So in Archaeological context pure metallic zinc is rare. The production of zinc on an industrial scale has been found only from China and India before 18th century. The metal zinc was produced by the reduction of calamine with charcoal.

The ancient ores of copper sometimes contain enough zinc that produces low zinc brasses by smelting. Cyprus (2000 BCE) had become one of the major sources of copper in the Middle East. Artifacts found containing up to 9% of zinc. Most of the artifacts containing 3-5% of zinc are produced by smelting of zinc bearing ores. Brass was certainly produced in Asia Minor from the 8th to the 7th Century BCE. The alloy found at Gordion, the ancient capital of Phrygia contains only 2 % of zinc. Brass also was

imported from Asia Minor to Greece in the 4^{th} Century and from the 6^{th} Century. Greeks used significant quantities of brass for its colour and rarity (McNeil 1990).

The homeland of brass manufacture seems to have been Asia Minor, where zinc in metallic form was produced and used for brass making in the 4^{th} century BCE. Romans were making brass on large scale by the cementation process by the 1^{st} century AD though there is few evidence of metallic zinc in Athens. The Etruscans were producing statues from brass in the fifth Century BCE. Brass reached late in Egypt not earlier than 30 BCE, when Rome was very familiar with brass (Agrawal 2000).

Hua Zeming (1997) claims that the earliest evidence of brass have been found from China from the Yang-shao culture in Shaanxi province dated to 4700-4000 BCE. However Craddock and Zhou commend that these isolated examples did not play vital role in the development of brass technology in China rather developed by Buddhist monk around 2000 years ago. The production of zinc by distillation process at Zawar in Rajasthan dated to 14^{th} century AD and probably much earlier and a link existed at the period between European and Indian alchemical workers. The evidences suggest that the brass containing metallic zinc was first made in Asia Minor before 800 BCE. The manufacture of natural zinc alloy in Shangtung province was around 2000 BCE and use of copper-nickel-zinc ore for bronze manufacture developed with the idea of identity of zinc as a metal and brass is an alloy were discovered indigenously out of the Western World (McNeil 1990).

Few bronze containing zinc in addition to the tin have been found from Middle East from the early 1000 BCE. The bronze bowls excavated from Assyrian city of Nimrud in northern Mesopotamia contains several percentage of zinc in addition to the usual tin content. These evidences suggest the presence of zinc in natural ores. The evidence of smelting of lead, silver, zinc ores have been found from Andria in north-west Anatolia. Some corroded zinc was excavated dated to 4^{th} to 2^{nd} Century BCE. Small denomination of brass coinage emerged by the beginning of 1^{st} Century BCE. The composition of brass coinage suggests that it was made by direct reaction of calcined zinc ore with copper known as cementation process in Europe. This method was continued

for making brass until the 19th century. In this process zinc carbonate ores (smithsonite or calamine) was separated from lead ore and then calcined. It was then mixed with charcoal and copper in closed crucibles and heated to around 1000^0C. The charcoal reduces the ore to produce zinc vapour. The amount of zinc which could be absorbed was limited in this method and on the other hand presence of impurities in the form of iron mineral dissolved in the brass and sometimes discolours the metal (Craddock 1987).

Copper zinc alloy emerged sporadically in South-West Asia during 3000 BCE and continued until the Greco-Roman period (Craddock and Eckstein 2003). Zinc oxides ores rarely occur in the Middle East and zinc-lead-sulphide deposits were probably used as the source of ancient zinc oxides here. The evidences were found at the sites Tepe Hissar in northeastern Iran (2.3 o 14.0 % Zinc) dated to 3000 BCE and Balya in Northwestern Anatolia (3.2 to 30.3 % Zinc) dated to 1st millennium BCE (Pigott *et. al* 1982).

The history of brass and zinc in China is divided into four stages: accidental brass, imported brass, cementation brass and speltering brass. Few scattered pieces of brass were discovered at the Jiangzhai site of the Yangsho culture I (4700-4000 BCE) in Xi'an, Shaanxi province. The metallurgical analysis reveals that brass contains 25.6-32% zinc. Two brass awls were excavated from Longshan Neolithic Culture (2300-1800 BCE) in Jiaoxian, Shandong province with 20.2 to 26.4% zinc. Brass perhaps was produced by smelting mixed copper ores and zinc ores in rudimentary condition. These are called accidental brass. They did not play any role in the development of zinc production technology in the Far East (Zhou 2001).

Cementation brass was imported via Silk Road from the Western Region, mainly Persia and India during the Han Dynasty around 2000 years ago with the introduction of Buddhism. The imported brass was called '*toushi*'. Buddist sculptures, incense burner, and small sized objects like needles, belts and seals made of '*toushi*' have been reported. Few brass objects were also reported from Yingpan cemetery, in Xinjiang province dated to 4th century AD. This brass is made of 20-22% zinc. Some metal fragments with content of zinc have been found at Xiangbei cemetery (late 5th Century AD) and Tubo

cemetery (9th Century AD). Some brass vessels were reported from Xianjiang province dated to 9th to 13th centuries. All these are imported brass and there is neither historical document nor archeological evidence of domestic brass making before the 10th Century (Zhou 2012).

Cementation method of '*toushi*' making with copper and '*luganshi*'(oxidic zinc ores)was first described by Chinese alchemist during AD 907-960. The method was described as one *catty* (c. 0.6 kg) of red copper, one *catty* of '*luganshi*' and eight *catties* of charcoal produces cockscomb-coloured pellets. During Song Dynasty (AD 960-1279) this method was mentioned as smelting of three *catties* of copper with one *catty* of '*luganshi*' produced one and half *catties* of '*toushi*'. Then the knowledge of '*toushi*' making spread to common people. Common people tried remelting of copper coins to make brass and the practice was forbidden by the Government soon. The import of '*toushi*' ceased with the decline of the Silk Road. In this period the brass was called '*huangton*' (literary yellow copper). It was precious and often used in temples and palaces. The brass was produced in large scale from the Ming Dynasty for making coins (Zhou 2004).

Brass was not common in China before16th Century (Craddock 1987). The first brass coinage was found from Hong Zhi period (AD 1505). The zinc content regularly over 30% suggesting that metallic zinc was used. Zinc was first produced in China in the early 17th century. The brass coins made after 1621 contains higher cadmium levels than those made before. The presence of higher cadmium suggests transition from cementation brass to speltering brass during AD 1621-1627. Chinese zinc was used for making brass coins and copper based artifacts and exported via maritime trade during the late Ming and Qing period. Brass was considered as luxury metal and was only used in palaces and temples in the late Ming Dynasty. Brass was also used for manufacturing vessels, figures, architectural fittings and astronomical instruments. Zinc was also used for making *paktong*, which is an alloy of copper, nickel and zinc. Brass was also exported to the other regions of the world (Zhou 2012).

The traditional zinc smelting technology evolved in southwest China throughout the 20th Century (Craddock and Zhou 2003). The process is called '*tufa*' literally means 'domestic method' and in English as 'traditional'. The archaeological evidences of zinc smelting are zinc ores, coal and fire clay. The zinc distillation technology is much more improved than the cementation process and also suitable for mass production. In China generally lidded cylindrical retorts with internal condenser were used. There are ceramic partitions called pockets, between the upper condensation zone and the lower reaction zone. These retorts were charged with zinc ores and coal and were heated in rectangular furnace with coal fuel. Zinc vapour was formed in the reaction zones and ascended via the hole of the pocket and condensed in the upper zone (Zhou 2012).

There is also an opinion that knowledge of zinc spread from India to China, but the process used by the Chinese was completely different from those of India (Craddock 1987). Zinc distillation in China was based on principal of distillation by ascending, which is fundamentally different from Indian process of downward distillation. However the zinc distillation process in China was reconstructed with the help of contemporary ethnographic study due to unavailability of archeological sources.

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2.16 Technology of making brass objects in India:

The technology of making brass alloy depended on the collection and extraction of zinc from zinc ores. The metal technology involved mainly done in two parts, i.e. processing of ores and casting or shaping of artifacts. However in archeological context main emphasis is given on smelting of ores in early stages rather than casting and shaping of artifacts.

2.16.1 Smelting Process of zinc:

Zinc metallurgy was developed much earlier in India and China than in Europe (Deshpande 1996). Zinc was extracted from ores in ancient times by distillation technology. The earliest literary evidence of metallic zinc on a regular basis comes from

India (Craddock 1987). Different smelting process of zinc was described in Sanskrit text of medicinal chemistry and alchemy: *Rasarnavam Rastantram* (500-100 BCE), *Rasaratnakara* (2nd Century AD), *Rasprakash Sudhakar* (12th Century AD) and *Rasaratnasamuchchaya* (late 13th Century AD) (Agrawal 2000).

The earliest method of zinc smelting in Zawar is dated to 840±130 BP (around 1150 AD). The distillation process used in Zawar mines is unique because zinc was extracted from ores by downward distillation. At first the ores were broken in sizable and beneficiating pieces. Then it was mixed with the charcoal dust and fired into a heap to convert into oxide. Again more charcoal powder, salt and borax as a flux were mixed with the roasted ores with cow dung and water. Then balls with 5 to 10 mm diameter were made from the mixture by hand rolling. The ores and fluxes in the balls stop the charge falling out and facilitate the escape of the zinc vapour during firing. The sun dried pellets then filled into the brinjal shaped retorts. The conical clay condenser head and neck was luted onto the retorts with clay to prevent air gap. A stick was pushed up the condenser through the charge and allowed to burn out, leaving a central hole running though the length of the charge in order to create clear route for the zinc to escape from the retorts. The sealed retorts were then ready for firing (Biswas 2001).

The exterior walls of the furnace are regular course of brick and the inner walls were plastered with clay. The furnaces are standing eight courses high from the plinth of the stone on which the furnace is based on the rim. The interior walls are much irregular and the gaps are filled up with clay and refractory fragments. The area was paved with large flat bricks in front of the furnace.

Two groups of furnaces have been found during the excavation of 1983 at Zawar. A single bank of seven furnaces upon Zawar Mala has small retorts (20 cm long and 10 cm in diameter). However the extensive arrangement of furnace has been found in old Zawar with larger retorts (30-35 cm long and 10-15 cm diameter). In both types of furnaces 36 retorts in an arrangement of 6x6 were contained within the truncated pyramid of each furnace. Thus 252 retorts could be fired simultaneously in a single bank. The retorts were supported vertically on perforated bricks through which the condenser tubes

passed into the cooler zinc collectors in the lower chamber. Each distillation unit is composed of two parts: The zinc vapour condensation chamber was at the bottom and furnace chamber at the top was in the form of truncated pyramids. The lower chamber was more or less square in plan and separated from upper chamber by perforated bricks. The internal dimension of the furnaces at the base is 660 mm x 690 mm. It is slightly wider across the side with the entrance of the lower chamber (Biswas 1993).

The lower chamber is divided from upper chamber by four perforated bricks (55 mm thick). These perforated bricks are fitted closely together and resting on a projecting brick ledge at the side and supported by a single clay peg providing support in the centre. These perforations include circular holes of two sizes: 9 larger holes are 35 mm in diameter at condenser necks, and 26 smaller holes for the passage of air to the furnace and drop through of ash (Craddock *et al.* 1985).

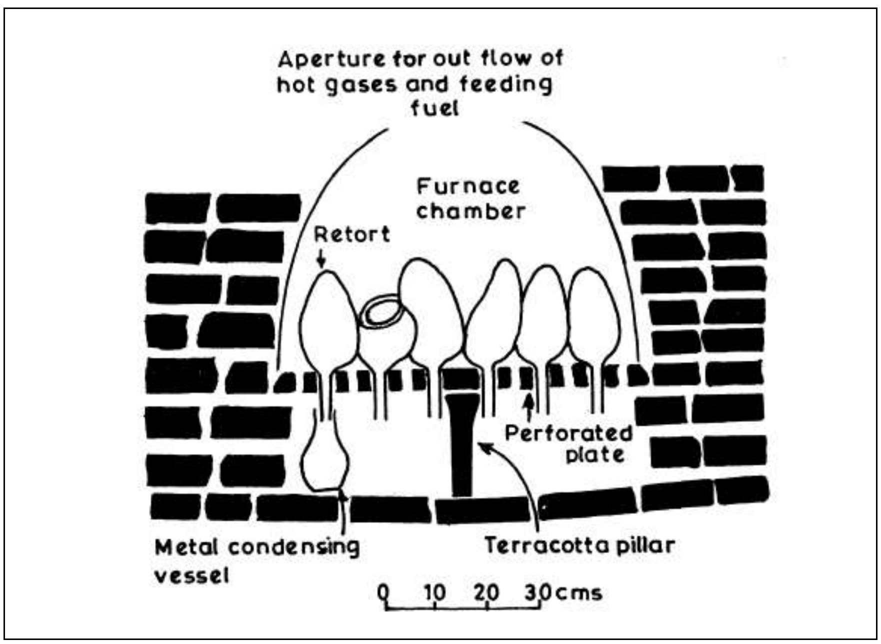


Fig 5: Cross section of ancient furnace for distillation of zinc excavated from Zawar (Srivastva 1999)

Plate 2: Zinc smelting furnace of Zawarmala, interior surface, outer surface (Srivastva 1999)

Charged retorts were arranged vertically on the perforated terracotta plates in the truncated pyramid chamber. It is also assumed that vessels were placed beneath the each retorts to collect the condense zinc vapour. The apparatus was designed in such a way that at high temperature solid charge was held in the upper inverted pots with sealed mouth with clay and a fixed reed stick at the centre for escape of the gases. The temperature inside the retorts reached to 1100^0C and along the condenser the temperature drops below the boiling point of the zinc (913^0C) but remain above the melting point (432^0C). The highly reducing condition had to be maintained through the system otherwise the zinc oxide produced would reoxidise in the condenser soon. This temperature had to be maintained in all the areas of 36 retorts. This needed skilled and technically sound metal smiths and Zawar process perhaps was the ancestor of all high temperature distillation process (Craddock *et al.* 1985).

The distillation process of Zawar mines is unique because it is the most unusual technology which has no similarity with any other parts of the world. The technology was neither antecedents nor successor rather independent invention in the area. The distillation technique was traditionally similar to the China but condensation method of zinc vapour is different.

The technology progressed during the medieval period. The retorts residues suggest that that the smelting charge included small quantity of common salt and large quantity of carbonaceous matter apart from the calcined ore, and then rolled into pellets of 1 cm^3 volume. The clay retorts were loaded with the charge of about 1.5 kg per retort. These were fitted with funnel like condenser tubes. The crucibles were brinjal shaped. When the furnace was heated, zinc oxide was reduced by the carbonaceous matter to zinc vapour. The temperature reached in the zawar zinc distillation furnace was from 1150-1200^{0}C and was maintained for 5 hours or more. The zinc oxide was achieved at a very low partial pressure of oxygen to prevent reoxidation of the metal. In around 500^{0}C temperature zinc vapour condensed in the tube and collected in the vessels placed beneath. This downward distillation is produced under a highly reducing atmosphere. The process was described in *Rasa Ratna Samuccaya* (Biswas 1993).

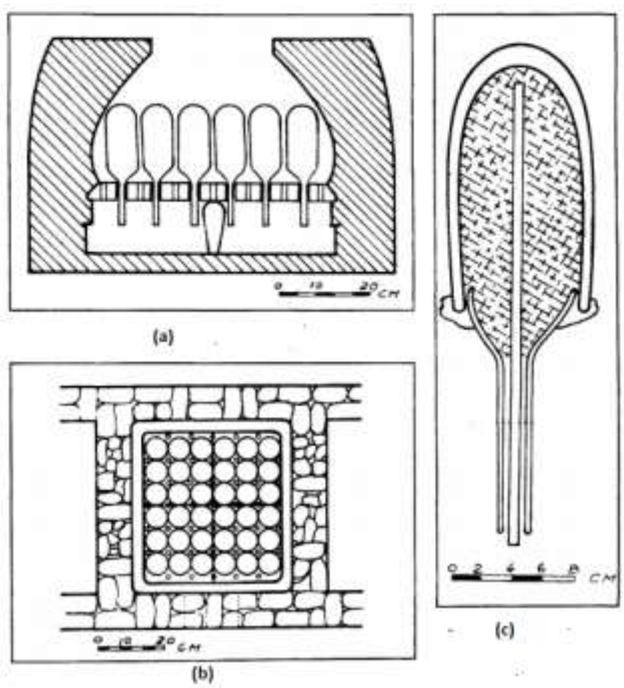


Fig 6: (a) Midpoint vertical section, (b) Horizontal section, (c) section through small charged zinc production (Craddock et al. 1985)

It was estimated that 200-500 b zinc was extracted per retorts, or 7-18 kg per smelt of 36 retorts. Each retorts is about 3 kg in weight. The debris of 6 lakh tons of spent retorts correspond to 1 lakh ton of zinc. The calculation of ratio of debris and extracted zinc revealed that 1 lakh ton of zinc was produced during 13^{th} to 18^{th} Centuries AD at Zawar (Freestone *et al*. 1985).

2.16.2 Cementation process:

The Greek '*orichalcos*' was equivalent to '*arakuta*' as mentioned in *Arthasashtra* by Kautilya. It belonged to 4^{th} Century BCE. A popular name for brass in ancient India was '*riti*'or '*ritika*'. The word perhaps was derived from '*harita*' or yellow, which was used as a synonym for gold in the Vedic literature. The word may have been chosen for yellow colour of gold-like brass. '*Pushpanjan*', referred in *Caraka Samhita* and *Sustrata Samhita* was used for the treatment of eyes and wounds, is probably zinc oxide. Brass is also found in the writings of Manu, Yajnabalka and Patanjali. These sometimes refer to Bronze (*kamsya*) and brass (*ritika*) (Biswas 2001).

Nagarjuna was a famous alchemist of ancient India. He boosted up the tradition of brass which had originated in India as early as 2000 BCE. There was extensive brass trade prevailed in Central India, Gujarat and other areas of the subcontinent. The secret art of zinc distillation was practiced in Rajasthan and Gujarat and utilized by Kushans, Parthians and Scythians and was passed on to the Satavahana civilization by Nagarjuna in the 2^{nd} Century AD. Proofs of the earliest discovery of zinc are two types. First is the brass containing 28% of zinc and other is the literary evidence of Nagarjuna. The earliest literary reference of zinc as a metal is found in Nagarjuna's *Rasa-Ratnakara* (RR), where he mentioned that *rasaka* (zinc) roasted with three parts of *sulva* (copper) converts the copper into gold. The appearance of gold colour was possible due to the presence of 25% of zinc. This is known as '*pita-tala'* or yellow alloy from which the term *pitala* have been derived. The proportions of metal also prove that brass was made by mixing of metals by cementation process. He also mentioned about the process of reduction of zinc (*rasaka*).

It was roasted with reducing agent and borax in a covered crucible. In early sixth Century AD Varahmihira in his text *Brhatsamhita* mentioned about *p9000* or cement recipes containing 'ritika' or calx of brass. By the seventh century AD India has well established tradition of brass making (Biswas 1993). The alchemic texts dated from 10th to 12th Centuries AD also explained different kind of brasses such as *Rasarnavam Rastantram* recorded early zinc making process (Craddock *et al.* 1989). These literary evidences suggest that the zinc was known in India much earlier than the dating of commercial production of zinc in Zawar.

There is evidence of brass before the discovery of zinc in India around 5th to 4th century BCE. Brass in Lothal (2200 -1500 BCE) and Atranjikhera during the PGW era (1200-600 BCE) were made by cementation process. The brass of Lothal contains 70.7 % of copper with 6.04 % zinc. The raw material was used probably from Ahar-zawar area. The Harappan site Rosdi in Gujarat has yielded a few samples of chisel, celt, rod and bangle made of brass which contain up to 1.54 % zinc. The analysis of metal remains found from Atranjikhera suggests that similar metal was used for making brass with 6.28 – 16.20 % zinc. Both the samples have traces of iron and sulphur and indicate that perhaps chalcopyrite and sphalerite-galena were the source material supplied from Ahar-zawar area. Zinc ores like sphalerite or zinc oxide was smelted along with the copper. The tradition of making philosopher's wool (ZnO) and cementation brass was continued even after the discovery of the distillation process of making zinc (Biswas 2001).

The distillation process of making zinc and alloying with molten copper was only the technology of production of high zinc brass (more than 28%), such as, the vase excavated from Bhir mound at Taxilla dated to 4th century BCE. The brass sample contains 34.34% zinc, 4.25% tin, 3.0% lead, 1.77% iron and 0.4% nickel. This was the strong evidence of the availability of metallic zinc in the 4th Century BCE. Possibly India was the first to make the metallic zinc (*rasaka*) by distillation process (Biswas 2001).

The process of downward distillation of zinc and its mixing with copper to make brass *oreichalkos* (*Arkuta in* Kautilya's *Arthasastra)* was described in detail in the post-Christian era Sanskrit texts. In Greek *oreichalkos*, literally meaning "copper of the

Mountain".It was quite possible that zinc making technology travelled from India to the western countries during 6th to 5th Centuries BCE and again in the 18th century AD. The Indian metallurgy emphasis was given on the 'gold- like' brass and Greeks had carried out the material and technology of Taxilla as early as 4th Century BCE. Possibly it was dated earlier in Rajasthan (Biswas 2001).

Some brass objects also have been studied by Neogi (1979). Brass articles have been found of 1st Century AD or BC by excavation of ancient *stupas*. The excavated materials include copper box enclosing brass cylindrical box cast which were turned on the lathe.

Both brass and bronze coins were used in Ancient India. There are evidences of circular punch- mark brass coins of Dhanadeva and Aryavarma of Ayodhya dated to 1st Century BCE. Brass coins of kings of several other dynasties have also been collected. Die-struck coins of Pre Gupta and Gupta Periods were made of brass including a piece attributed to Chandragupta II. From the huge archeological remains of numismatic it is clear that brass was in common use in ancient India during the 1st Century BCE (Biswas 1993).

Some of the typical brass objects have been found in ancient India up to 11th Century AD before the advent of Muslim period. Gujarats had important role in brass technology since the Harappan era. There are three hoards of metal objects in Gujarat. They are Mahudi of north Gujarat, Lilvadeva in North-east and Akota of central Gujarat, dated between 6th to 11th century AD. These hoards developed different types of alloy such as bronze, zinc-bronze, lead brass, conventional brass. The copper zinc ores of Ambamata in north Gujarat was also used for smelting. A large number of brass coins have been found from 5th to 12th Century (Biswas 1993).

In medieval period there was a large-scale manufacture of zinc and brass in India. The brass icons of India dated to the period AD 1350-1752. The metallurgical analysis shows that the brass contains high percent of zinc (35-40%). After 1752 AD the Zawar production was slowed down due to famine and Maratha invasions (1800 AD). Moghuls

had used brass for manufacturing buns and famous *bidri* alloy. The artisans of Bidar used high zinc brass (84%) or bidri alloy for ornamentation over it by gold or silver wire. The *bidri* are generally made with 95% of zinc and 2-10% of copper with other impurities. The term *bidri* has been derived from its place of origin in Bidar, Karnataka. This is placed just at the opposite ends of zinc copper alloy. It is also established that the technology of Zawar in India was transferred to Bristol in England sometimes before 1730. So there is no dispute regarding the primacy of India on brass and zinc metallurgy in the ancient and medieval World (AD (Biswas 2001).

The earlier studies have been concentrated on the metallurgical analysis of artifacts to understand the nature and concept of alloy through time and space. Main emphasis was given on the smelting and reduction process of metals from ores in most of the cases. The method of casting, fabrication and shaping of brass in ancient period is not reflected in most of the study. It can be assumed that the technology of manufacture of brass items may have some similarities with the manufacturing of copper items, which was studied by Kenoyer and Miller (1999) in the context of metal technology of the Indus tradition. There is an attempt in the present research to study the early technology of alloying of brass and its manufacturing process in Eastern India. The site Kuanr in Keonjhar district of Odisha is unique in the sense that there a hoard of brass artifacts were found from the site in Chalcolithic context. The metallurgical analysis of these artifacts may provide valuable data about the early technology of alloying brass and the process of manufacture of the ornaments in Chalcolithic period of Eastern India.

2.17 Chalco-Neolithic findings of brass at the site of Kuanr in Keonjhar district of Odisha:

Kuanr is the first reported Chalco-Neolithic site of Keonjhar district in Northern Orissa (Ray 1993). The site is on a mound and named after the nearby village Kuanr (21^{o} 30’N, 85^{o}28’E). It is situated on the north west of the NH6 near the culvert no.378. The mound is about 600 m above the sea level. The site is naturally fortified with the presence

of *Masani nalla* and *Ghumura nalla*, which are the tributaries of River Baitarani on its north, South and eastern side respectively. The village Kuanr is situated on the Western site. The mound is easily accessible from the Western side because it gently slopes down towards the village Kuanr. The upper part of the mound is almost flat and southern side is very steep, almost a gorge is formed. This area is covered up by jungles. The northern side of the mound is highly dissected and a number of runnels formed along the edges especially towards the *Ghumura nalla*. Cultural remains were found from the runnels. A part of the mound is used for agriculture at present.

Stratigraphy of the site has been observed by natural cliff section and trial digging. The Pleistocene bed is identified by gravel and silt layer, which is superimposed by a thin layer of *ghutin* which demarcates the Holocene bed. The soil of the top most surface is yellowish brown in colour but the eroded lower portion is reddish in colour. The texture of the red soil is coarser than the surface soil and mixed with grits and sands. This bed has yielded the cultural materials.

The area where the site is located is highly favourable for human habitation. Surrounding forest is rich in resources of livelihood and the area is well watered by various streams. The flat top is favourable for human habitation and the site is fortified itself by the gorge like streams on the three sides. The tributaries of the river provided requisite water and aquatic food. The land on the western, southern and eastern sides was suitable for cultivation. The nearby hill ranges provide raw materials for manufacture of tools, wax, lac, metal ores and fuel for metal casting.

Several seasons' exploration and trial digging had yielded assemblage of artifacts, such as, stone tools, potsherds, terracotta pieces, burnt clay pellets and metal ornaments. The stone tools collected from the surface may be typologically classified as axes, adzes, sickles, saddle-querns, ring stones, hammer stones, various types of scrapers, points, blades, awls, borers, knives as well as large quantity of flakes or chips. Both finished and unfinished tools as well as waste flakes and cores are found in large quantity. Some new tool types in the form of wedge, sickles and knives have been found. The stone assemblage suggests that Kuanr was used for habitation purpose site as well as factory

site. The majority of tools were made from altered basalt with few made of milky quartz and chert. The flake tools were made by prepared core technique. The celts were made by chipping, pecking and grinding method. Flutted cores are the byproduct of blade technology and microliths.

Terracotta objects consist of fragmentary potsherds, crucibles and burnt clay pellets. The potsherds are thick, sand and grit tempered mostly red ware. Few black ware, brown slipped ware and chocolate brown ware also have been found. Few red pot sherds are made from well levigated clay. Pots were either handmade or wheel made. The common form is vase as well as lid, handi and bowl. Potteries with internal or external grooves and sometimes corogation marks have been noticed. The base portions are flat in nature. A number of burnt clay pieces have been found which are small, ovoid in shape with a small pointed protrusion at one end. These could be pellets for slings which are common in the area, meant for stunning small preys.

2.17.1 Brass objects:

A large number of metal objects in the form of various types of ornaments are found. The ornaments consist of broken as well as complete bangles, rings and pendants. A complete necklace made of carnelian beads and brass pendants were found. Three amulets and one piece of bell have been found from the site.

a. Brass bangles:

More than a dozen metal bangles were found so far. Different types of designs are curved on the bangles. Diameter at inner side of the bangles varies from 4.6 -5.4 cm and at the outer side it ranges from 6.4 to 6.8 cm. The thickness of the bangles varies from 0.3 to 0.8 cm. The bangles vary in weight ranging between 38 and 40 gm. Most of the bangles have diamond shaped relief designs on them. Some bangles have protrusion at regular intervals, others with zig zag and saw like edges on flat bangles and some with spiral motifs. The naturalistic design includes flower petals. The design like flower of

banyan is locally known as '*batafala kharu'* in Oriya. This design at present appears to be preferred by local Juang women residing in the area.

b. Brass bell*:*

The specimen is a cross cut small tinkle bell, 5 gm. in weight. It is a hollow metal object meant to produce sound. The bell is 2.8 cm. in length and maximum breadth is 1.7 cm. The crown of the bell is 0.8 cm. It has a loop used for tying and hanging. The bell is of the same type as used by the dancers.

c. Brass amulets:

Amulets made of brass are four in number. One is broken. The size ranges from 1 cm. to 1.6 cm. The loops are small and about 0.3 cm diameter. These were probably talisman. Similar types are used by the local people at present.

d. Necklace with brass pendants:

A complete necklace made up of carnelian beads and brass pendants was found during the last session of trial digging (2009-2010). The design is reconstructed on the basis of the occurrence and alignment of pendants and beads. The pendants are unequal in size but similar in shape. These are horse shoe shaped in outline with a protrusion with hole for threading on the middle of the convex side. There are nine such pendants, one in the centre and four at each side. The central pendant is the largest in size and gradually decreases in size on either side of the necklace. The gradual length of the pendants as arranged in the necklace is 1.6, 2, 2.1, 2.5, 2.6, 2.4, 2.1, 2, 1.8 cm respectively. The beads are cylindrical in shape and more or less equal in size and are made of carnelian. These beads were perhaps perforated by hand drills. A few brass beads also have been found.

Plate 3: Brass ornaments from the site Kuanr in Keonjhar district of Odisha

2.17.2 Metallurgical analysis of the brass:

Archaeo-metallurgical analysis of some of the bangles found from the site suggests that the ornaments are made up of very old type of brass, alloy of copper, zinc and tin. The alloy was composed of 54% of copper with more zinc (33%) in comparison to a small amount of tin (8.5%) with other impurities (Ray *et. al.* 2000: 364-365).

The brass produced by cementation process contains up to 28% of zinc. The brass containing more than 28% of zinc could be made only after the isolation of pure zinc metal. The brass of Kuanr contains 33 % of zinc. The presence of high percentage of zinc content of brass found from the site is conspicuous. As per the earlier evidence that came from Taxilla (400 BCE), India got the primacy of zinc and brass production in India. The present evidence of the brass pushed back the date to the Neo-Chalcolithic period, dated to the second millennium BCE.

The presence of impurities in alloy is also very important to know the types of ores from which the metals are extracted. In the present findings brass impurities are 1.0% lead (Pb) and 2.5% iron (Fe) indicating the reduction of copper from chalcopyrite and zinc from sphalerite-galena. The Ahar-Zarwa area is also famous for this type of ores

as the sources of zinc. The metal smiths of Kuanr probably collected copper and zinc ores from the nearby rock outcrops.

2.17.3 Technology of brass making in Eastern India:

Brass technology is divided into two major steps; the reduction of metal from ores and metal casting. No major evidences of ore reduction have been noticed from the site. It was also found in earlier studies that copper and zinc were smelted and reduction of ores had been done near the mining area. So the evidences could not be found at the site.

Analysis of brass objects found from the site Kuanr is done by the Department of Metallurgical Engineering in the year 1993. Analysis showed that presence of 2 to 3% of iron (Fe) and 1% of lead (Pb) may be due to simultaneous reduction of chalcopyrite (Cu, Fe sulphide) and Lead-Zinc (Pb-Zn) sulphide ore by charcoal.

From Kuanr a large number of crucibles with slag adhered to it had been found at the site. Crucibles are thick in nature, grit tempered and porous made from the locally available clay. The porosity of the fabric would have afforded efficient heat retention as well as protection against breaking as a result of expansion and contraction during heating.

The *cire-perdue* or lost wax process was used for casting brass ornaments in the area. The technology could be reconstructed with the help of metal ornaments and crucibles. An almost complete crucible was found from the trench. This is an important craft indicator of *cire-perdue* casting. The crucible has a maximum length of 9 cm with 8.6 cm of maximum breadth. The thickness is ranging from 1.3 to 3.1 cm. A channel having 5.8 cm length and 0.5 cm diameter is seen. This is the runner, along which the wax in the mould is run, leaving a gap into which molten metal can flow. The inner portion is slightly concave. There are two air holes for removing of molten wax and metal smokes (Plate 4, page no. 355). A comparison with the process of manufacture of brass

objects by the present day metal smiths of the state of Odisha suggests that the Knuar people employed the solid casting method to make brass ornaments.

The solid casting of lost wax process has different stages from preparation of wax to finishing. The wax was prepared after mixing with resins and heated. The replica of a model then prepared and designed. The designs were made by engraving of wax probably with stone knives found from the area. Sometimes thin wax threads are prepared to make flat model of ornaments like pendants. The wax channel was made for freeway of the molten metal. Then the model was covered up by the clay and crucible was prepared on it. The clay pipes were prepared which enclose the tip of the wax channel. This channel is noticed in the crucible found from the site. Then metals are put inside the crucibles and casting is done in the furnace with fire wood collected from the jungle. Metal smiths of Neo-Chalcolithic period were skilled craftsmen with the knowledge of alloying of metals and control of fire for temperature. The casted metals were opened after breaking the crucibles. Then these metal products were cleaned and polished. Some stone polishers have been found from the site.

It proves that the ore used by the Kuanr people are different from Zawar mines. There was indigenous development of brass metallurgy in eastern part of India, which is local in origin and developed with ideas and knowledge of metal smiths in the area. They were experts in lost wax casting technology as well as extractions of metals from ores and making of alloy. Biswas (1993) pointed out that brass could be made before the advent of distillation of zinc in India during fifth-fourth century BCE. This is also true in case of eastern India as per the evidence found from Kuanr.

The geophysical setting of the site is very important for the development of metal technology of the area. The sources of metal ores were from nearby hills. Wax, lac, fire wood were collected from surrounding jungle and locally available clay were used for making of moulds. Because of the availability of the primary raw materials in the vicinity, the site attracted the Chalcolithic metal smiths to settle here. They were also experts in stone tool making and pottery. The thick deposit, rich in archaeological material indicates that the site was inhabited continuously and served as habitation as

well as workshop site. Rich information about the life ways of the Chalcolithic people and metal technology of the area may be acquired through further systematic excavation. The metallurgy of brass is indigenous in origin in the area. There is no earlier evidence of brass in eastern India before that. Therefore this site is not only important to understand the emergence and development of brass technology in Odisha, but equally important for Eastern India. Tin is not common in eastern India rather zinc is easily available. It is possible that together with copper brass formed an important aspect of early metallurgy here.

Moradabad in Uttar Pradesh is considered the oldest brassware clusters in India and is also called 'Peetal Nagri' (Sachan *et al.* 2013). However the history goes back to 17th century during the settlement of Mughals. But the tradition of brass in eastern India is early in origin. According to Ghosh (1981) the tradition of metals in eastern India was flourished in Dhalbum-Singbhum area, from where it migrated to other parts of the sub continent. Present study also proves this hypothesis.

2.18 Life style of Neolithic-Chalcolithic people in eastern India:

Excavation and exploration of different Chalcolithic sites focuses on the rich metallurgical tradition from Neolithic-Chalcolithic period in Eastern India. There is no trace of copper in Neolithic period in Eastern India. Neolithic-Chalcolithic or Chalcolithic cultures have evidence of copper and its alloy. In Bihar the evidences of copper is found from Senuwar Period II, Sonpur Period I, Champa Period I, Chechar Kutubpur (Period IC), Chirand Period II, Taradih Period II, Oriup Period I and Maner Period II. In West Bengal Neolithic-Chalcolithic sites include Bahiri Period I, Baneswardanga Period I, Mahisdal Period I, Mangalkot Period I, Pandurajar Dhibi (Period IIA), Bharatpur Period I, Tamluk Period I, Tulsipur Period I, Dihar Period I. In Odisha the sites which yielded evidence of copper are Sankarjang in Angul District, Knuar in Keonjhar District, Golbai (Period IIA) in Khurda District, Gopalpur in Nayagarh District and Khambeswari Period II. During the Ferro-Chalcolithic period

copper also is found together with iron and black-red-ware from Bahiri I, Baneswardanga II, Mahisdal period II, Mangalkot Period II (Copper objects with a bronze bangle) and Pandurajar Dhibi (Period IIB & III). At these sites a number of iron objects were recovered together with copper objects and black-and-red ware.

The metallurgy in Eastern India was initiated at the Neolithic-Chalcolithic phase and the Neolithic stone tools were used as model for the Chalcolithic tools. Copper Hoard objects of Eastern India are typo-technologically different from those of Western region. Arsenic and lead were used as alloying material for Copper Hoard objects and copper Bronze was independently originated here.

The overall pattern of culture suggests that the Chalcolithic people were an agricultural community in a rural set-up. The C 14 dates found from sites like Barudih, Chirand, Mahisdal, Bharatpur and Golbai put the Chalcolithic culture to 2nd Millennium BCE (Possehl 1988). The earliest date is found from Golbai, c. 2100 BCE followed by the date at Chirand, c. 1600 BCE. The date 2100 BCE of Golbai period IIa also provide evidence for the first use of Copper in the region. However Chattopadhyay and Sengupta (2011) mentioned the earliest date of copper is reported from Senuwar IB and dated to 1950 BCE. In the beginning of Neolithic-Chalcolithic Period copper was used in its pure native form which developed into the alloy technology within a short time period. The bronze bangle with 5.208 percent of tin (Singh 1999) was noticed from Senuwar Period II (Chalcolithic) dated to 1210 BCE. The knowledge of alloying improved with the time and high tin bronze was developed later perhaps from 300 BCE. It gradually merged into the Early Historic Period.

From the above discussion it is clear that the technology of copper-tin alloy developed later in Eastern India perhaps because of scarcity of tin. The Neolithic-Chalcolithic site, Kuanr in Keonjhar District of Odisha, is unique in the sense that the process of alloying emerged first in the site in the form of brass since the other sites in the area have the evidences of copper in its more or less pure form. As per the ^{14}C date of Chalcolithic culture of Odisha the brass assemblages of Kuanr many belong to 2100

BCE. Brass played an important role in the metallurgy of the Chalcolithic culture of Eastern India.

Chalcolithic people of Eastern India cultivated rice. Charred rice, husk, saddle querns, pestles are the evidences of rice cultivation. They also cultivated wheat, pulses and lentils. Cattle, buffalo, sheep, goat, pig were their livestock animals. Fishing was an important occupation as suggested by the presence of fish hooks and harpoons. Fish and turtle bones were also found. Hunting also played an important role in their economy. Deer, elephant, rhinoceros, buffalo, ox, wild pigs and stags were hunted. Neolithic ground and polished stone tools i.e. celts, saddle quern, pestles and microliths were also found as continuing trait. People also made and used pottery for both cooking and storing. The potteries are pre-Megalithic in type which included Red ware, Black and Red ware and buff ware. Terracotta pellets, figurines and phallus also were noticed with the fragments of the crucibles as the evidence of early metallurgy.

Chalcolithic settlement was well developed. Cluster of mud houses were used for habitation. Local ores were exploited for metallurgy. They extracted copper from chalcopyrite. There was specialized group of brass and copper artisans who were engaged in making ornaments and weapons. Evidences of beads are also found. They preferred mounds as well as alluvium plains for habitation. The sites were selected on the basis of proximity of water and cultivable lands, jungle for the supply of fuel woods and other forest products. The walls were wattle and daub, floors were made of beaten earth and roofs were thatched with straw. Ceremonial bars perhaps represented their ritualistic performance. Ritualistic behavior also has been identified by the presence of terracotta figurines and replica of phalluses and burial customs. Sometimes dead bodies were buried under the living floor associated with ornaments. The overall cultural pattern shows the gradual evolution of the culture from Paleolithic, Mesolithic and Neolithic periods to Chalcolithic; however the diffusion of ideas of the metallurgy from other regions as well as the influence of population migration should be kept in mind (Ray and Mondal 2013).

2.19 Summary of the chapter:

First experience of man with metal is copper. Earliest evidence of copper was found from South West Asia dated to 11th to 9th millennium BCE. Exploitation of native copper was found in 7th millennium BCE and it spread to the other parts of the world around 8th millennium BCE. In Indus valley native copper was found in Mehrgarh dated to 7th millennium BCE. Smelting of copper is dated to 6th millennium BCE in Central Asia and South East Asia. Metallic copper was found in Egypt around 4th millennium BCE. Bronze emerged in Southwest Asia at the end of 4000 BCE and diffused to Egypt and Mesopotamia, Central Europe and Central Asia around 3000 BCE. In China bronze developed around 2000 BCE and in Indus valley around 2700 BCE. However the fact that true bronze objects not been found in Harappa, prove the scarcity of tin. Only 14% of analyzed metal objects contain minimum amount of tin (8 to 12%). Metal technology of Harappa was highly developed. They were experts in cold work, annealing, shaping, casting and *cire-perdue* method.

In other parts of the Indian subcontinent copper technology flourished during Neolithic and Chalcolithic period. Neolithic and Chalcolithic culture of Northern India, Central India, Western India, Deccan and the Ganga valley was predominant by copper technology. In eastern India there was evidence of brass in Chalcolithic period. The method was indigenous in origin. The reduction was done by cementation method by mixing of copper and zinc ores over charcoal fire. This technology was earlier in origin, present before the production of zinc through distillation process, which developed in China during Buddhism and in India in the late 1st millennium BCE (Craddock *et al.* 1998). The tradition of brass work is continuing still today. A number of indigenous communities practice lost wax process of brass casting in different parts of eastern India. The study of this technology may reveal many hidden facts about metallurgy in the area and contribution of this indigenous technology to give rise to a well-developed and flourishing metallurgical tradition in the country as well as in other parts of the world. An attempt is made in the following chapters to highlight the preindustrial technology of brass work in eastern part of India.

CHAPTER III

3. AREA OF STUDY

The focus of the present study is on an area situated in the eastern part of India. The area comprises states of Bihar, Jharkhand, Odisha and West Bengal in Eastern India. Geographical location, political situation and geophysical setting of these states within the Indian subcontinent has been taken into consideration for understanding of proper location of the craft, network with other parts of the country in terms of availability and supply of raw materials, variation of technology and marketing of finished products. Geographical boundaries also play a crucial role for emergence, evolution and diffusion of the craft. Ecology of different geophysical setting also has effect on indigenous technology.

3.1 Indian subcontinent:

India is a vast country in the world's largest continent Asia. The country stretches about 2,900 km from $68^{0}7^{/}$E to $97^{0}25^{/}$E longitude. The land of the country comprises of mainland and a number of islands. The mainland is a large peninsula which is triangular in shape, bounded by Arabian Sea in the west, Indian Ocean in the South and Bay of Bengal in the east. The mountain ranges of Himalaya in the north separate the country from the rest of the Asia. The neighboring countries are china, Nepal and Bhutan at the north, Bangladesh and Myanmar in the east, Pakistan and Afghanistan in the west and northwest. Sri Lanka is separated from India by the Palk Strait in the south. The closest Southeast Asian neighbors are Indonesia, Malaysia and Thailand near to the Andaman and Nicobar islands.

The tropic of cancer runs about midway through the country and lies entirely in the tropical and subtropical regions of northern hemisphere. The geophysical settings and resources of India attracted people of different races and faiths from prehistoric period, which is reflected in the diversity of language, culture and biology. India is primarily based on rural and agricultural economy (Nag *et al.* 2011).

The subcontinent is divided into six zones. These are Southern zone, Northern zone, Central zone, Western zone, Eastern zone and North-Eastern zone (Bhatt 2008). For the present study Eastern India is selected as there is the earlier evidence of brass and a number of communities are still practicing brass works in a traditional way.

Eastern India primarily covers major geo-political units of Bihar, Jharkhand, Odisha, and West Bengal. These states are not only different politico-administrative units but differences also are found in language, people, and geomorphology and eco-cultural attributes. The state of Bihar is on the middle Ganga plain and West Bengal on the lower Ganga plain. On the other hand Jharkhand and Odisha are on the eastern plateau. The eastern part of Odisha is on the east coast plain (Nag *et al.* 2011).

3.2 Eastern India:

Eastern India is comprised of both older and younger land formation like Archaean belonging to Pre-Cambrian period and Gondwana rocks belonging to Paleozoic period. These are mostly found in Jharkhand, Odisha and western part of West Bengal. The rest of West Bengal and the state of Bihar consist of recent alluvium, deposited during Quaternary period. The older alluvium and laterite belonging to Pleistocene epoch is found in adjoining areas of western part of West Bengal, southeastern part of Jharkhand and northern part of Odisha. The area of Jharkhand, Odisha and western part of West Bengal is undulating in nature. Both Jharkhand and Odisha are more rugged and wrecked by river valleys. Western part of West Bengal gradually rises and becomes more undulated and rocky until merging into Chotanagpur plateau. In comparison Bihar and West Bengal are more or less even in nature.

Different types of igneous and metamorphic rocks like khondalite, charnockite and gneiss are distributed in major parts of Odisha and Jharkhand. Igneous-intrusive like granite, grano-diorite is found in northern Odisha and southeastern part of the state of Jharkhand. Sandstone and shale and conglomerate are rock components sparsely distributed in the area. Transitional rock like quartzite and schist are common in northern part of Odisha, Southern part of Jharkhand and Southwestern part of West Bengal (Nag 1994).

The common minerals and ores are found mainly in Jharkhand and Odisha. These are bauxite, limestone, kaolin, graphite, slate, mica, tungsten, feldspar, manganese, kaolin, iron, copper and zinc. Iron, copper, mica and steatite are deposited in western part of West Bengal (Nag 1994).

Land formation and mineral resources are important in the present study in terms of the quality and availability of important raw materials for brass work viz., copper and zinc. Soil profile of the area is also important because of the availability of suitable clay for preparation of moulds and crucibles and also tempering materials.

The area under study is humid to Semi humid with average rainfall of 1000-2000 mm. The vegetation is tropical evergreen to tropical deciduous type ((Nag *et al.* 2011). The eastern India has both forested and arable cultivable land. The land of Bihar and West Bengal is very fertile and suitable for cultivation. Forest is both dense and open dominated by sal (*sorea robusta*). The common trees are mango, jack fruit, cashew, banana, litchi, papaya, tamarind, kusum and mahua. Deforestation prevails at present. Forest have important role in the development of the craft because the fuel required for metallurgy is mostly collected from Jungle. Eastern plateau and hills extends from Jharkhand and Odisha towards the East. Predominant crop in this plateau is millet. Bihar and West Bengal are located in Middle and lower Ganga plain respectively with predominant crop of rice. Earlier the area was the habitat of large animals in Jungle areas. Forest clearance and cultivation diminished the animal wealth. Tigers, leopard, bears, deer and wild hogs are the game animal. These became gradually scarce due to rapid

expansion of habitation area. Domestic stock mainly consists of cattle and buffalo with goat, chicken and pig (Bhatt 2008).

A number of communities practice brass work in different parts of eastern India. Main concentration are found in Patna in Bihar; Dumka, Hazaribag, Ranchi and Khunti of Jharkhand; Samabalpur, Sundargarh, Dhenkanal, Kantilo, Puri, Balkati, Bolangir, Mayurbhanj of Odisha; Berhampore, Nabadwip, Krishnanagar, Maldah, Hoogly, West Midnapore, Purulia, Bankura and Burdwan of West Bengal (Mukhejee 1978, Saraf 1982).

Figure 7: Map showing the distribution of brass artisans in eastern India. (Downloaded from http://www.mapsofworld.com)

Cluster is a geographical concentration (city / town / villages and adjoining area) of household units producing handicrafts, which represents the socio-economic heritage of the country. In present study main emphasis is given on Odisha and West Bengal for ethnographic study. Communities were selected both from rural and urban settings. The villages and townships inhabited by the brass workers have been studied intensively. Six clusters of brass artisans are selected for the present study. Out of these four are selected from the state of West Bengal and two from the state of Odisha.

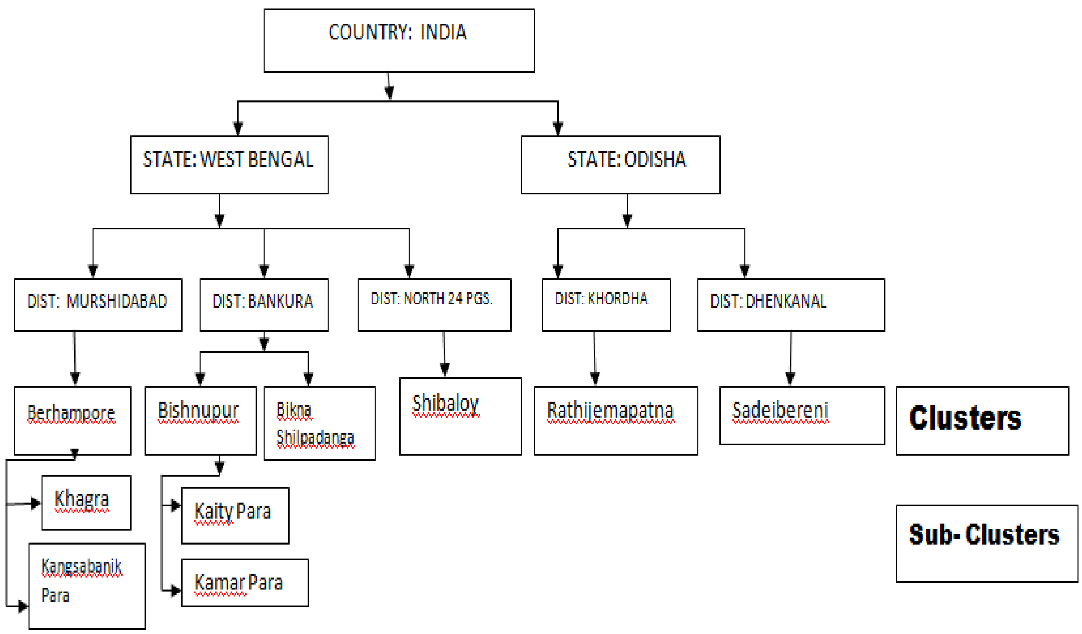


Figure 8: Distribution of clusters under study in West Bengal and Odisha

3.2.1 State of West Bengal:

West Bengal lies between $85^{0}50^{/}$ and $89^{0}50^{/}$ E longitude; $21^{0}38^{/}$ and $27^{0}10^{/}$ North latitude on the eastern bottleneck of India. The state stretches from the Himalayas in the north to the Bay of Bengal in the South with varied geophysical settings. The state has a total area of 88752 square kilometers and is bounded by the states of Jharkhand and Bihar in the Western border, the state Odisha in the southwest, Bay of Bengal in the south, the

states of Assam, Meghalaya in the northeast, and the state of Sikkim in the North. The adjoining countries are, Nepal and Bhutan in the northwest and Bangladesh on its eastern border. The capital of the state is Kolkata which is the third-largest urban agglomeration and the third-largest city in India.

Figure 9: Map showing the clusters under study in West Bengal. (Downloaded from http://www.mapsofindia.com)

The region probably was named after Anga, Vanga (also called Banga) and Gauda. This region has glorious achievements in the nineteenth and twentieth centuries. Prince Vijaya went to Sri Lanka from here carrying the message of the Buddha from this ancient land. Gupta, Pala and Sena dynasties also ruled over the region. British rule was first established in Bengal and they set up their capital in Calcutta. Present shape of the district was achieved after the partition of Bengal into two, East Bengal and West Bengal on August 1947.

West Bengal has varied topography, Himalaya Mountain in the north, extension of Chotanagpur plateau in the northwest, lower Gangetic plain and coastal plain. Important rivers are Ganga, Yamuna, Rupnarayan, Damodar and Subarnarekha. The district enjoys heavy rainfall in the southwest monsoon. Heavy rainfall helps to grow ample vegetation which produces valuable forest resources. Heavy rain and alluvium is also suitable for agriculture. Paddy is the principal crop. Other crops include maize, pulses, oilseeds, wheat, barley, potatoes and other vegetables. Tobacco and Sugarcane are also important cash crops. A number of large scale industries were developed. Small scale industries also are found good in number in different parts of the district. Varied geophysical set up and comfortable climate invite people from different parts of the country to settle here. As a result a number of language groups are found with different religious faith (Bhatt 2008). For present study three districts have been selected. These are; Murshidabad, Bankura and North 24 Parganas. A number of brass and bell metal centers are distributed in these districts.

3.2.1.1 District- Murshidabad:

The district Murshidabad within the Presidency division is a triangular tract and centrally located the state West Bengal lying between $23^{o}43^{/}$N and $24^{o}52^{/}$N latitude and $87^{o}49^{/}$E and $88^{o}44^{/}$E longitude. It has a total area of 5316.11 sq. Throughout the eastern boundary of the district the River Padma flows separating the district of Maldah and Rajsahi of Bangladesh. Bardhaman and Nadia districts are in the Southern side. Birbhum

and Jharkhand are on the western side of the district. The district has 5 Sub-divisions, viz. Berhampore Sadar, Jangipur, Lalbag, Kandi & Damkol. There are 26 Community Development (C.D.) Blocks (District Census Handbook, 2011).

Table 2: Important statistics of the district Murshidabad, W.B.
(Source: District Census Handbook, 2011)

Categories of population	Male	Female	Total
Population	3,627,564	3,476,243	7,103,807
Rural Population	2,917,822	2,785,293	5,703,115
Urban Population	709,742	690,950	1,400,692
Literates	2,177,187 (66.59 %)	1,878,647 (63.09%)	4,055,834 (66.59%)
Scheduled Castes	460,143 (12.68%)	437,391 (12.58%)	897,534 (12.63%)
Scheduled Tribes	46,163 (1.27%)	44,872 (1.29%)	91,035 (1.28%)
Total Workers	1,985,667	604,240 (17.38%)	2,589,907
Workers in household	117,511 (5.92%)	348,496 (57.68%)	466,007 (17.99%)
Area (in sq Km.)	5324		
Sex Ratio	958		

Origin of the name Murshidabad is contentious. The earliest name was 'Masumabazar' or the market-town. It was derived from the word '*masuma*' meaning a

chaste lady who was a wife of a noble man. According to '*Bhavishyat Purana'* (A.D. 15^{th}-16^{th} century) the name was '*Morasudabad*', which was founded by '*yavana*', that is a Muslim. The district was also named as Makhsusabad or Makhsudabad and later replaced as Murshidabad, where the provisional revenue headquarters was shifted from Dacca in 1704 by Murshid Kuli Khan, the Diwan of Bengal. The place was also called Makhsusabad after name of a merchant Makhsus Khan, who built *sarai* there. There is also an account that first it was called 'Colaria', then 'Macsoodabad' and finally 'Moorshoodaabd'.

The human habitation on the western part of the river Bhagirathi started from the end of the Neolithic period and continued to Chalcolithic and early historic periods. Archeological excavation yielded the history of the district during Maurya and Gupta periods. The history of Murshidabad is almost associated and interlinked with the history of Bengal. In 5^{th} Century a part of the district was under the rule of Gupta Empire. In truest sense the history of the district started with the Karna Suvarana, a metropolis which was ruled by the Bengal's first sovereign monarch Sasanka in the 7^{th} Century A.D. In the eighteenth century Murshidabad again became the capital of the last independent Muslim ruler of Bengal and witnessed most important political activities of the country. Hiuen-Tsang came to Bengal in about 638 A.D. and mentioned the kingdom of Karna Suvarna as an important centre of learning and existence of many Buddhist monasteries. After a long anarchy Gopala, the king of Pala was elected around the middle of the eighth century. Dharmapala, son of Gopala succeeded his father around 770 A.D. and during his tenure the Pala Empire reached the peak of its glory. After Pala dynasty Sena dynasty came to reckon as the premier political power of Bengal during the tenure of Vijayasena (c. A.D. 1095 to 1157). After Sena period the district went under the Sultanate rule after the invasion of Bakhtyar Khalji in Bengal in A.D. 1201. In 1206 A.D. the western part of the Bhagirathi of the district went under the domination of Bakhtiyar Khalji. Sultan Gihyasuddin Iwaz Khalji (circa AD 1213-27) controlled the northern Radh area. The Bagri area went under the control of Delhi Sultanate after Lakhnauti in 1259 AD. During the next three hundred years Bengal witnessed several types of political upheavals. After Sultanate rules there was a brief era of Shahi dynasty. Mughal rule in Bengal began when

Emperor Akbar's General Munim Khan moved from Bihar towards Bengal and took into the custody of Bengal's capital Tanda (near Goud) without a fight in 1574. In 1700 A.D. the history of Bengal took a new turn with the appointment of *Faujdar* of *Makhsudabad* and the *Diwan* of Subah Bangla by Emperor Aurangzeb. In 1704 MurshidKuli Khan, the *Diwan* of Bengal shifted the capital of Bengal from Dhaka to Murshidabad. After death of MurshidKuli Khan his son-in-law Shuja-ud-daulla (1725- 39) and then Alibardi (1739-1756) became *Subedar* of Bengal. In 1756 after the death of Alibardi his grandson Siraj-ud-daulla succeeded him as *Nawab* of Bengal and became the victim of the joint conspiracy between Mirjafar and Mr. Watts of the British East India Company. East India Company won the battle of Plassey on 23rd June, 1757. Then Mirjafar became the *Nawab* of Bengal and became puppet in the hands of the East India Company. Mirkashim was defeated in the battle of Buxar in 1764 and the revenue management of the whole of Bengal was handed over to the East India Company in 1765. As the company in Calcutta became the supreme revenue management authority the central of power was shifted from Murshidabad to Calcutta. The famine of 1770 and the transfer of Diwani officer to Calcutta enhanced the decline of Murshidabad rapidly.

The district also witnessed the Muslim revivalist movement, The Revolt of 1857, the Indigo Rebellion, Hindu reform movement, Freedom movement (The Swadeshi), Extremist movement, Founding of the district Congress Committee, Founding of the District Committee of the Muslim League, August movement. Present district of Murshidabad came into existence in 1787. In August, 1947 after the partition by mistake Murshidabad went under the jurisdiction of East Pakistan. However after the announcement of Radcliff award the district became a part of West Bengal. It is also notable that the district unofficially remained as a part of East Pakistan for a few days after partition although it was officially a part of West Bengal.

Geological formation of the district belongs from Jurassic to recent. Jurassic deposition consists of basaltic lava with shale and clays found in Rajmahal trap in the northern part of the district. The Pleistocene formation found in the form of older alluvium and lateritic clay at the major part to the west of the river Bhagirathi. The recent

formation has been found at the eastern part of the river Bhagirathi in the form of recent alluvium. Different types of soils like clayey soil, loamy soil have been found and all of the types are very fertile and produce almost all types of crops.

The district is located centrally in the lower Ganga valley and the river Bhagirathi divided the district into two parts: the eastern part and the western part. The eastern part of the district is known as Bagri and the western part of the district is known as Radh. The Radh area exhibits an appreciable elevation and the range of Rajmahal hills slopes gently down in this tract. It is the continuation of Vindhyan region with presence of lateritic clay and nodular ghuting and intermingled with numerous swamps and beds of old rivers. The eastern part of this slopes are marked by cliffs, bluffs and some hillocks covered with *Sal* and *Mahua* trees are found here. The undulations are interspersed by rivers. There was a strip of low-lying area of about 388 sq. km. in the north. There is a treeless plain of about 129 sq. km. in the south known as *hijal*. It was extensively used for pasturage and characterized by the growth of *hijal* trees. The eastern part of Bhagirathi is an alluvial plain between the Bhagirathi, the Ganges and the Jalangi rivers. The south-eastern corner of the district of about 129 sq. km. is a vast swampy tract of dark clay and popularly known as *Kalantar bil.* The elevation from 10m to 50 m above the MSL makes the district vulnerable to flood during monsoon.

Soil of the Bagri area is alluvium and very fertile growing *aus* paddy, jute and *rabi* crops. In Rarh area the soil is hard lateritic clay suitable for growing winter paddy and sugarcane. Mulberry grows well in this type of soil and hence sericulture has developed here. Important rivers system of the district consists of the Ganges and its tributaries namely Bhagirathi, Jalangi and Bhairab. Bansloi is an important tributary of the Bhagirathi enters from the district of Birbhum. Climate of the western side of the Bhagirathi is drier and the eastern part of the Bhagirathi is humid. Climate of the district is characterized by a hot summer, short winter, high humidity and good rainfall during monsoon. In summer the maximum temperatures often exceed 40°C during May and June. The temperature falls to 9° C – 11° C between December and January. Annual

rainfall of the district is of approx 1,600 mm (62 in). Floods are common during Monsoon, causing loss of life, destruction of property, and loss of natural resources.

Flora of the district resembles the deltaic area of West Bengal. Bamboos are scattered all over the district. Numerous marshy and floating species are available in the swampy areas. Bamboo is scattered all over the district. Common plants are mango (Mangifera indica), jackfruit (Artocarpus heterophyllus), bable (Acacia nilotica), simul (Bombax ceiba), sisso (Dalbergia sissoo), babul (Acacia arabica wild). The other indigenous and exotic plants are Ficus bengalensis, tamarind (Tamarandus indica), coconut (Cocos nucifera), date-palm (Phoenix sylvestris) and areca nut (Areca catechu). Different varieties of mangoes are cultivated under the patronage of wealthy people like Kohinoor, Anupam, Champa, Shahadulla, Rani Prasad, Begum Pasand, Nawab Pasand, Shiraj Pasand.

Wild animals which were found earlier disappeared at present. Only jackles are found. The common fauna are monkeys (the black-faced *Hanumans),* snipes, wild ducks, pigeon, geese. As there are many water bodies like rivers, canals, lakes and ponds different species of birds are found including some migratory species. The district falls within the major rice growing area of Bengal. Wheat, maize and barley are occasionally cultivated. Common vegetables are potato, brinjal, gourd, pumpkin, bottle gourd, cucumber, tomato, radish, carrot, beet, cabbage, cauliflower (Bhattacharya 1979).

Two sections of the Eastern Railway Sealdah – Lalgola and Sealdah-Katwa Ajimganj are located on western and the eastern side of the river Bhagirathi. The National Highway No.34 passes through the district. The Farakka Bridge is an important communications point both the northern and southern parts of the district. The district is provided with a well managed transport system both private and public, connecting the different parts of the district.

Primary languages spoken in the district are Bengali, Hindi and Urdu. By religious faith Hindus and Muslims are predominant. Other marginalized groups are

Christian, Sikhs, Buddhists, and Jains. Brass artisans of Murshidabad district live in clusters in Kandi, Boronagar and Berhampore.

Figure 10: Map showing the location of clusters in Murshidabad district, W.B. (Downloaded from http://www.mapsofindia.com)

3.2.1.1.1 Berhampore / Baharampur:

The manufacture of brass products in Berhampore has been exiting for long time. Berhampore (24°4′N 88°9′E/24.067°N 88.15°E) which is also spelled as Berhampur or Baharampur, situated on the alluvium plain of eastern bank of the river Bhagirathi. It is 187 km (by rail) north of Kolkata. Baharampur is the administrative headquarters of the Murshidabad district. Berhampore was fortified in 1757 by the East India Company, after the Battle of Plassey in 1757, and it continued as a cantonment until 1870. All of the major European colonial forces came to Berhampore and early settlements of Dutch, Armenians, French and British could still be seen scattered in the city. Famous industries

include silk weaving, ivory carving, conch shell working, rice and oil-seed milling and precious brass and bell metal working. Baharampur is also popular for a special type of fried sweets, locally known as "*Chanabora*".

The name Berhampore is possibly derived from the corruption of name Brahmapur i.e. the city of Brahma. Brahmapur was the name of the original moujah, derived from the place having been a settlement of Brahmanas. The derived name ‘Baharampur’ was used in the 14th or 15th century A.D.

Present work is carried out in Berhampore municipal area (24°6'N, 88°15'E). Total area of Berhampore municipality is 31.42 sq. km. According to Census 2011 total population is 195,223 (male100,247; female 94,976). Literates are 163,312 (male 85,970; female 77,342). Household industry worker of the area is 377 (male 94; female 283).

a. Khagra:

Khagra is famous for the centre for the manufacture of brass objects existed for a long time. Khagra is one of the constituents of the Berhampore municipality under the jurisdiction of ward no 16 in the Behrampore police station in the sub-division of Behrampore Sadar in the district of Murshidabad. Post office is in Khagra. In khagra area the artisans are distributed in Kansari Para lane, Ramsundar Munsi lane, Indraprastha, Kantanagar, Jaychandra Road, Saidabad and Dayanagar. Though the main concentration is found in Kansri Para Lane and Ramsundar Munsi lane. At the eastern and southern part of Khgra there is Bishnupur bill, which looks like a horseshoe lake. B.B. Gupta Road is at the west of Khagra. The river Bhagirathi flows from north to south at the western side of the Khagra area.

According to local legends the artisans were taken to from Boronagar area during the Bargi invasion by Alibardi Khan. They started to live here after clearing the forest of tall reed, locally known as ‘*nalkhagra’*. The name ‘*khagra’* was derived from the name of

these wild reeds. The name of the famous bell metal '*khagrai kansa'* was also derived from this name.

The area is in the alluvial plains generally sloping towards the western side. Soil is sticky clay and during the monsoon the soil becomes muddy. The soil of the area is more or less fertile and suited for raising paddy. Agriculture was practiced earlier, now it is found in few pockets. Area becomes flooded during rainy season.

The persons belonging to the Kangsa Banik caste live in groups. The term 'Kansari Para lane' generally means a locality mainly inhabited by persons belonging to Kangsa Banik caste. According to local legend the first settler of the area are Kangsha Banik. A number of residents were engaged in the manufacture of brass products for a long time. There are also some practicing artisans who belong to different castes. Therefore the residential area is patterned on considerations of occupations and not of caste. So the set-up of the area reveals that it is inhabited both by the practicing and non practicing artisan families belongs to different castes namely Brahmin, Teli, Jele, Bairagi, Gop, Jugi, Gandha Banik, Swrna Banik and Baishya.

The Kansari Para lane was taken off from the main road known as B. B. Gupta Road. The Lanes and by lanes are metalled with sanitary drain by the sides of these lanes. Waste water from houses is drained out by this drainage system which is again connected with main drainage system of the city. The settlement pattern is linear type. Houses of the artisans are located on both sides of the lane. All of the houses are brick built *pucca* houses and sometimes double storied. Habitations are congested and gap between two houses are narrow. The workshops are adjacent to the houses. Floor of the workshops is made of hard beaten mud. Almost all three sides are open for ventilation of heavy smoke and heat created during metal working. All of the houses have latrine and urinals. The tube well in the courtyard is the sources of water both for domestic and drinking purpose.

The area is a commercial centre for brass working. The artisans can collect raw materials from the market and also can sell their products easily in the market. The middlemen also have brass and bell metal shops in the Khagra market. Various brass

products were meticulously designed by master craftsmen. Traders and visitors would come here to place orders for new products and to take delivery of the finished goods in earlier times. Those days are gone and the artisans have no regular work now and income has fallen. So a number of artisans left brass work and shifted to other occupations.

Figure 11: Bird's eye view of Kansari Para Lane, Khagra, Murshidabad District, W. B. (Map downloaded from https://www.google.co.in/maps)

b. Kangsabanik Para:

Kangsha Banik Para in Saidabad, Kunjaghata is another cluster of brass working artisans in r. The area is under the jurisdiction of ward no 16 of Berhampore municipality in the Behrampore police station in the sub-division of Behrampore Sadar in the district of Murshidabad. Post office is in Khagra. The place has historical significance. There is a palace of Maharaja Nandakumar built in 1757 A.D The area is bounded by Maharaja Nanda Kumar Road at the south and eastern sides, in northern and western side the area is bounded by Kazi Nazrul Sarai Road. The brass working communities live here are by

caste Kangsa Banik. They migrated from neighbuoring country Bangladesh and settled here 50 to 60 years ago. The first settlers of the area were also Kangsa Banik.

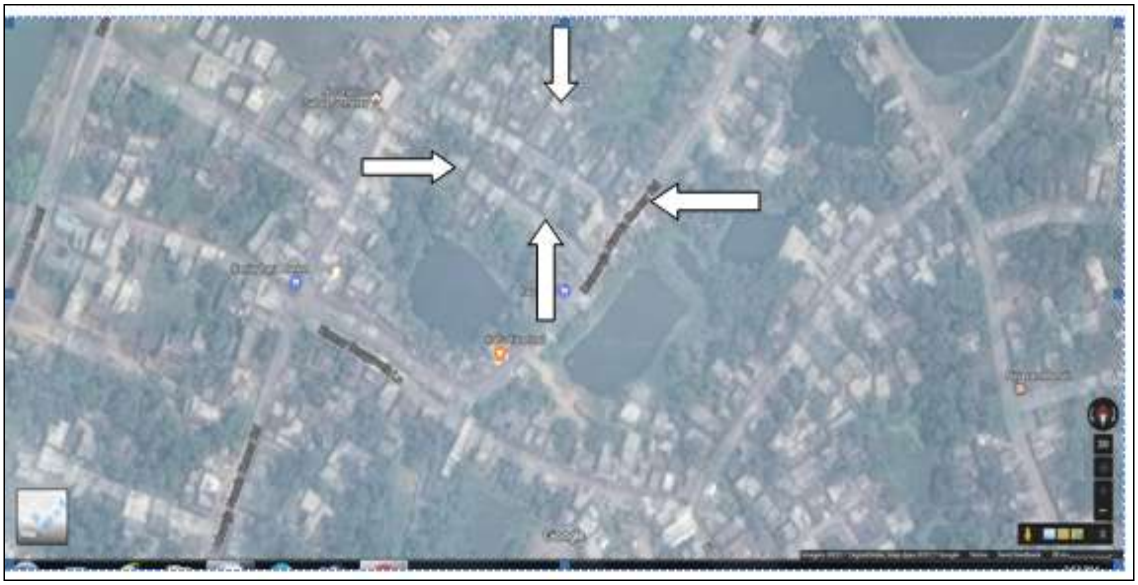


Figure 12: Bird's eye view of Kangsabanik Para in Murshidabad district of W. B. (Map downloaded from https://www.google.co.in/maps)

The river Bhagirathi flows from North to South direction at the west of the area. This area is also situated on the fertile alluvial plains. The settlement is in low land area from the road and sloping towards the western part to the river. Most of the houses are Pucca houses, sometimes with tiled or asbestos roofing. There are courtyards in the middle of the houses. Courtyards are not cemented, which are used for different activities of brass work. Workshops are also made of bricks with roofing of asbestos or in. Sometimes verandah and the space under the stair are used as workshop. Every house is provided with latrines and urinals. Houses are fortified with high brick walls to maintain the secrecy of the craft. Tube wells are the sources of drinking water. The people also bath nearby Bhagirathi River.

Groups of Kangsa Banik caste live in groups. The term Kangsa Banik Para generally proves the dominancy of the caste of the area. They live with other caste groups

namely Jele, Jugi and Moira in a particular social set-up. Nearby markets are Kunjaghata and Khagra. Artisans can directly sell and delivery their products to the metal shops of these markets.

Both these areas are under Berhampore municipality. The community development block is Berhampore. People of Baharampur enjoy city life. The city provides facilities of education, health care and job opportunities which are more money making than brass working. There are a number of primary, secondary and higher secondary schools both for boys and girls. Degree College both boys and girls are also situated in the city. They also enjoyed medical facility. There are eight health centres run by the Municipality. Sadar hospital, mental hospitals are within the municipal area of Berhampore.

Baharampur is well connected with different parts of the districts as well as with other adjoining districts. Nearby railway station is Berhampore Court and Cossimbazar. Khagra Ghat Road is another station, 2 km from Berhampore Municipal area, which is in the Howrah-Azimganj railway route. The area is well connected by NH 34, from Kolkata to North Bengal. There are two bus terminuses and regular bus service is available to other parts of the district as well as with the other districts. Beside this there are thirteen (13) municipal markets and two (02) private markets. Municipality has two (02) burial grounds and two (02) cremation grounds. The area is near the Khagra market. Khagra is one of the prime market areas of Baharampur city.

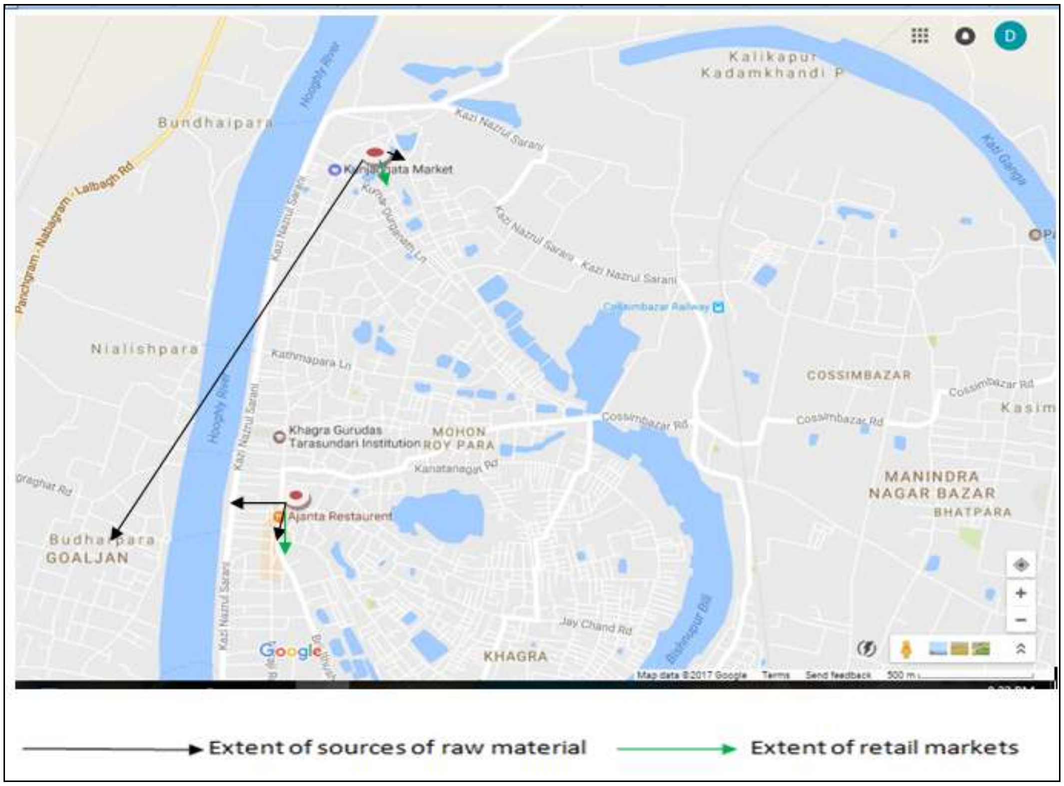


Figure 13: Map showing the extent of retail markets and sources of raw materials in Berhampore, Murshidabad, W. B.

((Map downloaded from https://www.google.co.in/maps)

3.2.1.2 District- Bankura:

The district Bankura within the Bardhaman division situated on the western periphery of the state of West Bengal and extends between $22^{0}38^{/}$ and $23^{0}38^{/}$ North latitude and between $86^{0}36^{/}$ and $87^{0}46^{/}$ East longitude. The district is bounded by the districts of Bardhaman at the north and a part of northeast separated by Damodar River, the district of Hugli at the south-east and districts of Purulia and Midnapur at the south-west.

Table 3: Important statistics of the district Bankura, W.B.
(Source: District Census Handbook, 2011)

Categories of population	Male	Female	Total
Population	1,838,095	1,758,579	3,596,674
Rural Population	1,685,777	1,611,124	3,296,901
Urban Population	152,318	147,455	299,773
Literates	1,299,337 (80.05 %)	933,655 (60.05%) %)	2,232,992 (70.26 %)
Scheduled Castes	593,440 (32.29 %)	581,007 (33.04 %)	1,174,447 (32.65%)
Scheduled Tribes	183,467 (9.98 %)	185,223 (10.53%)	368,690 (10.25 %)
Total Workers	1,050,822 (57.17 %)	415,398 (23.62 %)	1,466,220 (40.77 %)
Workers in household	29,999 (2.85 %)	31,387 (7.56 %)	61,386 (4.19 %)
Area (in sq Km.)	6882.00		
Sex Ratio (No. of females per 1000 males)	957		

According to 2011 census total population of the district is 3596674 (Male 1838095, Female 1758579). Out of the total population 3296901 persons live rural areas and 299773 persons live in urban areas. Sex ratio is 954 per thousand male. Total scheduled caste and scheduled tribe population of the district are 117447 and 368690 respectively. Literacy rate of male and female are 80.05 and 60.05 in the district.

The district has been named after its most important town Bankura. There is no valid document related to the naming of the district of Bankura. According to local tradition the town was named after a tribal chieftain called Banku Rai. Another local legend is that the town was named after Bir Bankura, one of the twenty-two sons of Bir Hambir, Raja of Bishnupur. According to O'Malley (1908) "the name is a corruption of Bankunda, meaning the five tanks". In old official records the town was also referred to as 'Bankoonda' or 'Bancoorah' or 'Bacoondha'. Some says that the district was named after one of the most influential deities of the district Bankura Roy. There is also a local belief that the name of the district may have come from the word '*banka*' means zig-zag.

The sign of early human habitation is found from Susunia hill and its adjoining areas. The script in Prakrit and Sanskrit dated to 4th Century suggests that Chandravarman, son of Simhavarman, was the ruler Pushkarana (modern Pokhanna in Bankura district). After Gupta period the district was included in Sasanka's empire.

From 7th Century to the advent of British rule, the history of Bankura is related with the history of Rajas of Bishnupur, one of the oldest dynasties of Bengal. The district was under the rules of the Malla dynasty. The country under the rule of these Rajas is known as Mallabhum meaning 'the land of 'wrestlers'. According to *Annals of Rural Bengal* by Dr. Hunter, Raghunath Singh was the founder of the dynasty of Bishnupur. According to the legend Adi Malla became the chieftain and was known as Bagdi Raja. The successor Bir Hambir was powerful and converted to Vaishnabism by Srinivasa. Bir Hambir was succeeded by Raghunath Sing. Raghunath Sing built the temples of Shyamrai, Jor Bangla and Kalachand between 1643 to 1656. Next Prince Bir Singh took care about the beautification of the town. He built the present fort and had excavated seven big lakes or tanks, called Lalbandh, Krishnabandh, Gantatbandh, Jamunabandh, Kalindibandh, Shyambandh and Pokabandh. He built the temples of Lalji in 1658. His queens built Madan Gopal and Murali Mohan in 1658. At the end of the 17th Century after the death of Raghunatha Sing the invasion of Marathas occurred and also the encroachment by the Zaminders of Bardhhaman. Bankura was ceded to the British in 1760. In 1806 the estate was sold for arrears of land revenue and bought up by the

Maharaja of Burdwan. Until 1793 Bankura continued to form one district with Birbhum. The south-west part of the district became unrest due to *Chuar* rebellion in the end of the 18^{th} Century, when the district was a part of ‘Jungle Mahal’ under British possession and continued till 1833. In 1879 the district acquired its present dimension. It was still known as West Burdwan and untill 1881 the name Bankura was not given.

Total geographical area of the district is 6882.00 sq. km. The district Bankura is divided into three Sub-Divisions, viz. Bankura (Sadar), Bishnupur and Khatra. There are 23 Police Stations and 22 Community development Blocks. Out of these, Bankura (Sadar) Sub-Division consists of 8 C.D. Blocks, Bishnupur Sub-Division consists of 6 C.D. Blocks and Khatra Sub- Division consists of 8 C.D. Blocks. Head quarter is Bankura is a town known for its education, commercial, health, recreational and cultural activities. Other developing centers are Bishnupur, Khatra, Barjora and Gangajalghati. The district at present comprises of three (03) subdivisions, twenty three (23) Police stations and twenty two (22) Community Development Blocks. It extends from north to south 112 km. and 120 km from east to west.

The district is an intermediate region lying between the rice producing alluvial plains of West Bengal in the east and Chotanagpur plateau in the west. Topographically the district is divided into three zones (1) the hilly area to the west, (2) connecting undulating plain in the middle and (3) lower alluvial plains to the east. Isolated peaks are found where the alluvial plains merge with the undulating terrain at the west. Two hills of considerable height are Susuni and Biharinath located at the outliers of Chota Nagpur Plateau.

Geological deposition belongs to Archean to recent period and is noticed in the formation of Anothrosite, Gabbro-Granophyre complex, schist and Gneisse, Phylite, quartzite, epidiorite. The most striking geological feature of the district is the wide distribution of secondary laterite throughout the district.

The Damodar, the Dwarakeshwar, the Gandheshwari and the Kangsabati are the Principle Rivers of the district originated from the hilly stream of western upland and

marked by seasonal flow of water. Other smaller rivers are Silabati, Gandheswar, Sali, Jayponda which are mainly depended on rain.

The district is characterized by tropical dry and sub-humid climate with a hot summer which witnesses the maximum temperature of 40^0C. The mean daily temperature is 18^0C and annual rainfall is 1740 mm.

Forest covers about 21.05% of total land of the district. The forest is composed of tropical and dry deciduous forest mainly of *sal* (Shorea robusta). It has some economic value and sometimes cropped yearly for firewood. Tusser cocoons and medicinal plants are also produced in the jungle. The common flora of upland area are alkushi (Mucuna pruriens), amaltas (Cassia fistula), asan (Terminalia tomentosa), babul (Acacia arabica), bair (zizyphus jujube), bel (Aegle marmelos), bag bherenda (Jatropha curcas), bahera (Terminalia belerica), gab (Diospyros embryopteris), mahua (Bassia latifolia), kuchila (Strychnos nux-vomica), Mahua (Bassia latifolia), palas (Butea frondosa), sajina (Moringa pterygosperma), kend (Diospyros melanoxylon). Beside these the mango, date-palm, nim, pipal, banyan, red cotton and jiyal are common. In alluvial plains that is the eastern part of the district shrubs and small trees are common. These include red cotton tree (Bombax malabaricum), mango (Mangifera indica), jiyal (Odina wodier). The uses of these plants are multipurpose like building construction, carpentry, weaving, and medicinal use and also for fire wood.

The wild animals found in jungles of upland area are tigers, leopards, wild bear, hyenas, sloth bear. Other carnivorous animals are jackals, fox, civet cats, wild cats, wild pigs, wolves. Other common animals are monkeys, squirrels, porcupines, rat and mice. Game birds are pea-fowl, jungle fowl, quail and pigeons. Several species of wild goose, duck, snipe, water fowl are found with other common birds of West Bengal like vulture, fish-eagle, bulbul, sparrow, honey sucker. Beside these fishes and reptiles are also common in different areas of the district (O'Malley 1995).

The economy of the district is primarily rural in nature. Agriculture is the principal source of livelihood. Developed irrigation project enhance the crop production

of the district. Rice is the main crop. Wheat, pulses and vegetables are also cultivated. Cattle, buffaloes, sheep and pigs are major livestock of the district. There is very limited deposition of commercially important minerals such as coal, china clay, iron, copper, limestone, mica and wolfram. The industries have a very little bearing to the economy. Small scale industries are silk and cotton weaving, brass and bell metal utensils, pottery, lac and conch shell and terracotta work.

Table 4: Manufacture, export and import of important commodities of the District Bankura (Bhatt 2008).

Name of the towns	Most important commodity		
	Manufactured	Exported	Imported
Bishnupur	Brass utensils	Brass utensils	Silk Guti
Khatra	Lac	Paddy	Paddy
Patrasair	Bell metal and Brass utensils	Bell metal and Brass utensils	Bell and Brass metal
Sonamukhi	Silk Products	Jute	All kind of metals

The trading of surplus agricultural products such as paddy and rice played an important role in the economy of the district. The other products exported are wheat, pulses, sugarcane, mustard oil, vegetables, lac sticks, tobacco leaves, and cotton and silk products.

Transport and communication system of the district is well developed. The district is well connected by highways and South Eastern Railway. There are many interesting tourism centers like Mukutmanipur, Jhilmil, Bishnupur, Susunia, Jairambati, Panchmura which not only attract the tourist of the country but also from abroad. The places of tourist interest are centers of Dokra craft, terracotta and silk weaving craft centre, terracotta temples of Bishnupur and other religious places.

Different Hindu festivals are celebrated in the District like Durga Puja, Kali Puja, Saraswati Puja, Ratha jatra, Dol yatra and also some Islamic and Christian festivals. The ditrict level festivals are *Gajan* of Shiva, *Gajan* of Dharmaraj, Raash, Pancharatri and Jhapan festivals. The important fairs are Bishnupur mela and Adivasi festival (Bhatt 2008). Though Hindus (84.3%) are predominate in the district, people from other religious faith are also inhabited like Muslims, Christians, Sikhs, Buddhists, Jains and others. Languages spoken in the district are Bengali and Hindi primarily.

Figure 14: Location of clusters in Bankura district of West Bengal. (Map downloaded from http://www.mapsofindia.com)

3.2.1.2.1 Bishnupur:

Bishnupur ($23^0 05^/$N, $87^0 19^/$E) is a municipal town within the Vishnupur block, Bishnupur sub-division in Bankura district in West Bengal. It is located at an average elevation of 59 meters from sea level and the river Dwarakeshar at the northern border of the town. The total population of Bishnupur municipal town according to 2011 census was 67783. The Bishnupur municipality is bordered by the Darika Goswaipur Panchayat in the North, Morr Panchayat in the South, Pansuili Panchayat in the East and Dwadas Bari Panchayat in the West.

Bishnupur is 200 km from Kolkata by rail on the Adra-Khagargpur section of the South-Eastern Railway. The distance from Kolkata is 152 km. by road from Kolkata. There are regular bus services from other parts of West Bengal. The district is well connected by SH 2 from Onda to Jaypur and SH 5 from Onda to Paschim Medinipur (Administrative Atlas of West Bengal, 2012). The town has facilities of education. A number of Primary, Secondary, Higher secondary schools, Colleges, engineering colleges are located in the town. The town also enjoys modern facilities like electricity, telecommunication.

Bishnupur had a glorious past in the 17th and 18th centuries and it was the capital of ancient Mallabhum, which was a large territory comprising of the districts of Bankura, Medinipur and Bardhaman. The town was also spelled as Vishnupur after Lord Vishnu, the deity of Vaishnavite Malla kings. Bishnupur is famous for its beautiful temple architecture of terracotta like Malleswar, Madan Mohan, Murali Mohan, Madan Gopal, Jor Bangla, Lalji, Radha Syam, Rash Mancha. The town also surrounded by seven lakes called Lalbandh, Krishnabandh, Gantatbandh, Jamunabandh, Kalindibandh, Syambandh and Pokabandh for continuous supply of water throughout the year and also functioned as fortification. Bishnupur became a tourist spot and heritage town for its beautiful temple architecture of terracotta and handicrafts like pottery, brass work, silk weaving, conch shell work and others (Biswas 2003).

The economy of the town is based on trade, both wholesale and retail business, and traditional handicrafts of terracotta, brass, conch-shell, silk and cotton weaving. A large section of people are dependent on small scale household handicraft industries. A number of markets are distributed throughout the town namely Bishnupur market, Chak bazaar and Sankhari Bazar. The craft centers also grew up centering round the markets. The names of the place also imply the existence of market or trade centers namely Rasikganj, Madhabganj, Krishnaganj, Matukganj, Gopalganj.

The Bishnupur municipality is divided into 19 wards. The present work has been conducted in Kamarpara in Motukganj and Kaitypara in Krishnaganj.

a. ***Kamar Para (Motukganj):***

Kamar Para in Motuk Ganj is a hamlet inhabited mostly by Karmakar caste. It is located in Ward No-11 in Bishnupur municipality under the jurisdiction of Bishnupur Police Station in Bishnupur sub-division in Bankura district in West Bengal. Motukganj is located by the side of the Netaji Subhas Road near Pokabandh. The area is bordered by Netaji Subhas Road at the west, Rupkatha Cinema Hall at the east, Rathi temple in the north, Abra Pukur at the south.

Kamar Para is composed of number of household of both practicing and non-practicing artisans and other castes. The area is inhabited by different artisans like weavers and conch shell workers. The concentration of artisan families in the locality helped a great deal and social set up in the development of the craft in the area.

According to Chandra (2004) the history of the craft in the area goes back to four hundred and fifty years during Malla Dynasty. They came from Mayurbhanj in Odisha and settled here. By caste they were Rana Karmakar. They were experts in lost wax process, then slowly adopted the technology of making brass utensils.

b. *Kaity Para (Krishna Ganj):*

Kaity Para in Krishna Ganj is another centre of brass craft. It is located in ward no-12 in Bishnupur municipality under the jurisdiction of Bishnupur Police Station in Bishnupur sub-division in Bankura district in West Bengal. The area is located by the left side of Ahallabai Loop road. The area is bordered by Laljiu temple at the north, temple of the goddess Kailas and Bauri Para at the southwest, Ahalla Bai Road at the east and Jamuna Bandh at the west. It is located near Chak Bazar market.

The artisans were settled long back during Malla kingdom. Kaity para is a hamlet which is dominated by Karmakar caste. A number of artisans practicing brass craft live with other caste groups in particular social set-up. Other caste groups are dominated by other artisans.

Bishnupur is famous as a tourist spot. A number of tourists from the country as well as from abroad come to enjoy the marvelous terracotta temples scattered in the area. A number of crafts including brass have demand among the tourist. This is another reason for the development of the craft in the area. Tourist used to come and visit these temples and also buy different handicrafts including metals as souvenirs.

Figure 15: Bird's eye view of Kaity Para in Bishnupur, Bankura district of West Bengal. (Map downloaded from https://www.google.co.in/maps)

Both the areas are situated in same geophysical setting. The area is slightly undulated in nature. The reddish soil has greater portion of sand than the sticky clay, which is muddy but not sticky during the monsoon. The areas do not become water-logged in rainy season due to the nature of the soil. The roads are generally metaled. The lanes and by lanes are curved out from the main road. The settlement is linear types. Houses of the artisans are situated by the sides of the road. Most of the houses are brick built *pucca* houses, however a few kutcha houses are found with thatched or tiled roof. The houses usually have a verandah overlooking the road in front. The workshops are attached with the houses and sometimes it is situated as separate units. Tube wells provide drinking water to the people.

The studied areas are located near the market place. There are a number of metal shops in the markets. The artisans can supply the objects as per the demand of the owners, middle men and tourist who come to visit Bishnupur. The artisans can sell their products directly or through the middleman to the markets located nearby. The raw materials for brass work also are sold from the markets.

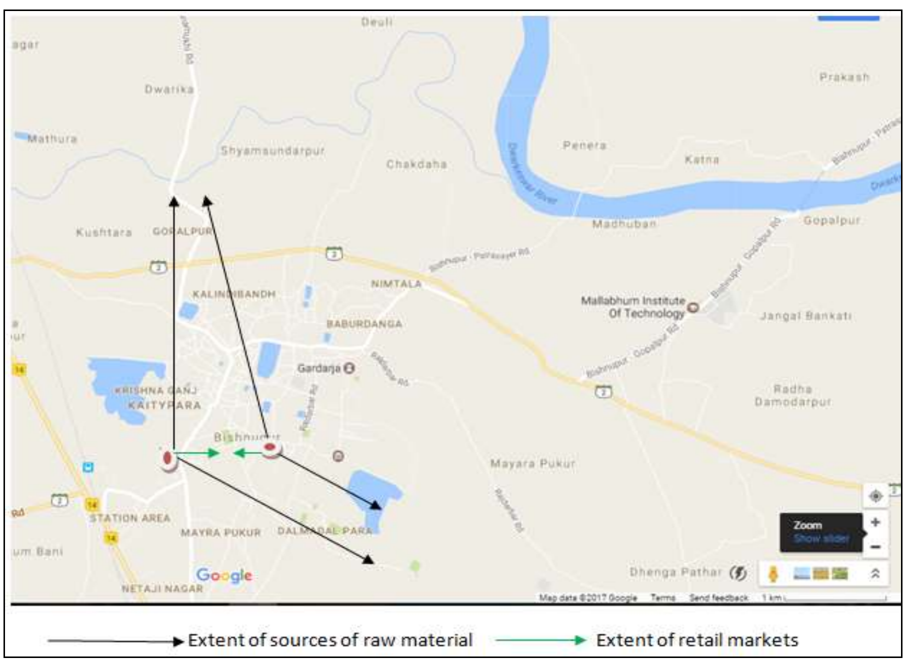


Figure 16: Map showing the extent of retail markets and sources of raw materials in Bishnupur, Bankura District, W. B.
(Map downloaded from https://www.google.co.in/maps)

District head quarter, Police station and community development block are within the Bishnupur municipality. So the people of the area can easily access modern services for education and health. There are number of primary and higher secondary schools, degree colleges, Music College and training Centre in Bishnupur. These provide facilities for higher education and technical training to get better job opportunities.

Both the areas are well connected with bus services with the different parts of the districts as well as outside of the districts. Bus terminus is within 3 to 4 km. and Bishnupur railway station is about 5 km. from these areas.

3.2.1.2.2 Bikna Shilpadanga:

Bikna Shipdanga (23°15/ N, 87°5/ E) has a cluster of Dokra artisans in Bikna village under Bikna Panchayet, Community Development Block Bankura –II, Police station Patpur, Sub-division Bankura Sadar, in Bankura District of West Bengal. The post office is Keshakol. It is located at the right side of the SH-9 near to the Heavyr more bus stop. The road goes to Asansole (66 km) and Raniganj (46 km). The village Bikna is surrounded by the adjacent villages namely Doman Bandi in the North, Mobarakpur in the South, Katnar in the East and Jagannath Bati in the West.

According to the local legend the artisans migrated from Rampur long years back. The heaps of byproducts of metal works created nuisance there. So they were forcefully evicted from their land. Then they settled here and worked as a labour in agricultural fields. As the brass work produced smokes government made a separate cluster for them away from the village.

The area is situated on the elevation of 89 m. from the mean sea level. The soil type is lateritic and yellowish red in colour. This type of soil is used making the mould of Dokra craft after cleaning and mixing with temper. The River Gandheswari, a tributary of Dwarakeswar flows from the southern part of Bikna.

A Shrine is present at the entrance of the cluster. The settlement pattern is dispersed in nature. The houses are not built in a planned way. Most of the houses are semi pucca house with thatched or tiled roofing. Mud houses with thatched roof are also found. Houses are not built on a raised platform rather it is in the same level with courtyard. There is no boundary wall for the houses, Sometimes common wall is shared by two houses.

In most of the time craft is practiced in the courtyard except in rainy season. The village pathway has branched out from the main road. The village roads are not metaled. It becomes muddy during rainy season. There is no personal latrines and toilets. Common toilets are shared. They also share common tube well for drinking water. The villagers enjoy modern amenities like education, health care, treatment of diseases and telecommunication. There are a number of primary, secondary, higher secondary schools near the Bikna village. Health care centre is in the village. Hospitals are in Bankura town.

Figure 17: Bird's eye view of Bikna Shilpadanga, Bankura District, W. B. (Map downloaded from https://www.google.co.in/maps)

The nearest Railway station is Bikna, 3.9 km. from the village in Narayangarh-Bankura branch of the Eastern railway. This is also connected with the Adra-Khagargpur section of the South-Eastern Railway. The stations Bankura and Bishnupur are 3.9 km and 30.2 km. from the village. The area is well connected by highway of SH-9 from Indpur to Barjora and SH-5 from Gangajalghati to Onda and Taldangra. The distance from Bankura railway station is 4 km. The nearby town is Bankura about 5 km. away from Bikna village. Bus services are also available within and outside the districts. Developed transport system facilitates to grow up of the craft in the area.

Artisans can attend different fairs and festivals arranged by the State and Central Government easily due to better communication. On the other, traders and tourist can directly visit the place and purchase the products per their choice.

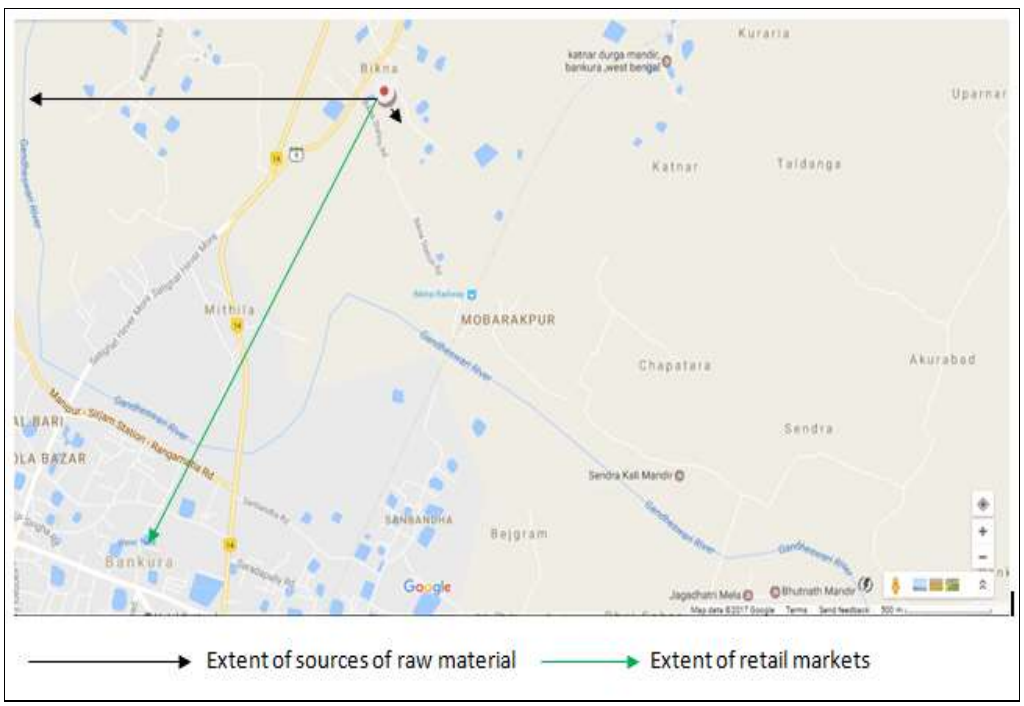


Figure 18: Map showing the extent of retail markets and sources of raw materials in Bikna, Bankura District, W. B.

(Map downloaded from https://www.google.co.in/maps)

3.2.1.3 District- North Twenty Four Parganas:

The district of North Twenty Four Parganas lies between 22°8” to 23°16”North latitudes and 88°18” to 89°4” East longitudes. The district is irregular in shape with natural water bodies as boundaries. North Twenty Four Parganas is bounded by the districts of Nadia in the north-west, the district of South Twenty Four Parganas and Kolkata in the South and South-west, Bay of Bengal in the South, the river Hugli is in the western border. The district of South Twenty four Parganas is in the Southwest. In the north the district is bounded by the international boundary of Bangladesh. The district got importance because of its proximity to Kolkata and the gateway to Eastern India. Total area of the district is 4,094 sq. kms. The district Head quarter is Barasat.

Table 5: Important statistics of the district North Twenty Four Parganas. (District Census Handbook, 2011)

Categories of population	Male	Female	Total
Population	5,119,389	4,890,392	1 0,009,781
Rural Population	2,196,554	2,081,065	4,277,619
Urban Population	2,922,835	2,809,327	5,732,162
Literates	4,056,046 (87.61%)	3,552,647 (80.34 %)	7,608,693 (84.06 %)
Scheduled Castes	1,115,458 (21.79 %)	1,053,626 (21.54 %)	2,169,084 (21.67 %)
Scheduled Tribes	134,179 (2.62 %)	130,418 (2.67 %)	264,597 (2.64 %)
Total Workers	2,945,189 (57.53 %)	626,435 (12.81 %)	3,571,624 (35.68 %)
Workers in household	81,434 (2.76 %)	74,328 (11.87 %)	155,762 (4.36 %)
Area (in sq Km.)	4094.00		
Sex ratio (No .of females per 1000 males)	955		

North Twenty Four Parganas District comprises of 22 C.D. Blocks and 29 Statutory Towns. There are total 1527 Villages and 78 Census Towns in the District. North Twenty Four Parganas is the most populated District of the State and it ranks 3rd in terms of Child (0-6 year's) Population in the State. The District occupies 2nd position in terms of Scheduled Caste Population in the State.

According to 2011 census total population of the district is 10,009,781 (Male 5,119,389, Female 4,890,392). Sex ratio (Number of females per 1000 males) is 955. Literacy rate is 84.06% (87.61% in male and 80.34% in female). Total scheduled caste population is 2,169,084 (Male 1,115,458 and Female 1,053,626) and scheduled tribe population is 264596 (Male 134,179 and Female 130,417).

The district was previously named as Twenty Four Parganas from which the district North Twenty Four Parganas was curved out in 1986. The evidence was from 2nd Century A.D. According to the writing of Ptolemy the ancient land of Gangaridi was stretched between the rivers Bhagirathi-Hoogly (lower Ganges) and Padma-Meghna. The archeological findings from Berachampa suggests that the area was influenced by the Gupta period though was not directly associated with Gupta rules. The district which was the south-west frontier territory of ancient Bengal was included in under the rule of Dharmapala (c. 770-810 A.D.). During the middle half of the 16th century A.D., the region was attacked by the Portuguese pirates. In the early 17th century, *Maharaja* (King) Pratapaditya fought against the Portuguese and resisted the onslought. In the mean time the British east India Company was strengthening their position in Bengal. After the battle of Plassey (1757) it was assigned to Lord Clive. After his death it came under the direct authority of Company again.

In 1793, during the rule of Lord Cornwallis, entire Sunderbans were under the district of Twenty Four Parganas. In 1834, the district was split into two districts – Alipore and Barasat. These were united later again. The district witnessed the first mutiny (1824), second mutiny (1857), *Neel* Revolt (1859-61). After Independence, an administrative reform committee in the year 1983 suggested splitting the district into two and in 1986 the district was bifurcated into two parts i.e. North Twenty Four Parganas

and South Twenty Four Parganas. The township of Bidhannagar or Salt Lake City of Kolkata is included in this district.

As the district is situated on the Gangetic delta, the district resembles deltaic land. The district lies on the new alluvium plain of the lower Gangetic plain. The land type is mostly plain and is a little raised above the flood plain. The soil type of the northern region is sandy, the central region is also sandy but mixed with clay loam and the soil of southern region is clayey loam. Physiographically the district is comprised of two regions both the dead delta condition of the north and mature delta plain from Barasat-Basirhat region up to Sunderban. The district comprises of three physiographic zones i.e. Ichhamati-Raimangal Plain occupies the northern and eastern parts, North Bidyadhari Plain extends in the central part, The flat raised alluvium strip along the Hugli River.

The main rivers of the district of North 24-Parganas is Hugli. Other remarkable rivers are Ichhamati, Kalindi, Raimangal, Dansa, Borokalagachi, Benti, Haribhanga, Gourchrar, Bidyadhari.

Tropical humid climate prevails over this district influenced by the tropical monsoon. Total rainfall of the district is 15.65 mm. Maximum and minimum temperature varies between 26°C and 12°C during winter and 36.5°C and 25.5°C in Summer.

Shrub and bushes are common in raised riverbank and in low lying area grasses and weeds are common. The forest is found in extreme south under the Sunderban Reserve forest. The forest preserve biodiversity of delta region including the species of *Sundari, Garjan, Garan, Keora, Bain, Hental* etc. The Royal Bengal Tigers and spotted deer are important fauna which survive in the Sunderban area. A wide range of bird species both native and migratory like ducks, fouls, storks, spoon bills etc. are found. Other aquatic species like large saltwater alligators, monitor lizards, turtles, crabs, shrimps and numerous edible fishes are common.

Agriculture occupies a significant position in the district due to availability of fertile soil. Rice, wheat, pulses, oil seeds and fibers are main crops of the district. Beside

agriculture animal husbandry and poultry are also practiced. Cattle, buffaloes, sheep and pigs are main livestock.

It is the biggest industrialized district of the state of west Bengal. The industries are concentrated along the river Hugli. The remarkable industries are manufacture of edible oils, weaving of cotton textiles in power looms, manufacture and fabrication of metal products. There is also good number of small scale industries in the district like cotton handloom, leather tanning, manufacturing of cutlery, brass and bell-metal industries, pottery, embroidery and lace works (chikan) dominated in many parts of the district mostly in the rural areas.

The district possesses well developed trading system with other parts of the country. Coal, raw jute, kerosene, petrol and diesel are imported materials are imported goods and finished jute products, cotton, chemicals, vegetables, cereals, poultry, jute are exported goods of the district.

The communication system is well developed throughout the district. The Sealdah division of Eastern railway controls long distance and local trains in four important sections. There is 181 km. railway from North to South. The district is well connected with National highway (NH 34 and NH 35), State Highways, district and village roads are maintained by State Public Works Department.

The spots which have tourist interest are Sundarban, Dakhineswar Temple, Nicco Park, Science city, Aquatica. Tourists are mostly attracted from the other adjoining districts of the state of West Bengal. The remnants of early civilization have been yielded from Chandraketugarh in Berachampa. This place is of interest of in international tourists. There are number of picnic spots by the side of the rivers and also in Sunderban.

As the district comprises of people of different communities, religious faith and culture the festivals of Hindu, Muslim, Christians and Jains are performed in different period of time. Common Hindu festivals are Durga puja, Deepavali, Rathajatra. Muhharam, Id-ul-Fitr, Idu’z Zuha are common festivals of Muslims. Christmas Day is

celebrated by the Christians. There is a tradition of *Shaiva*, *Shakta* and *vaishnabism* in Hindu religious faith (Bhatt 2008, Census of India 2011).

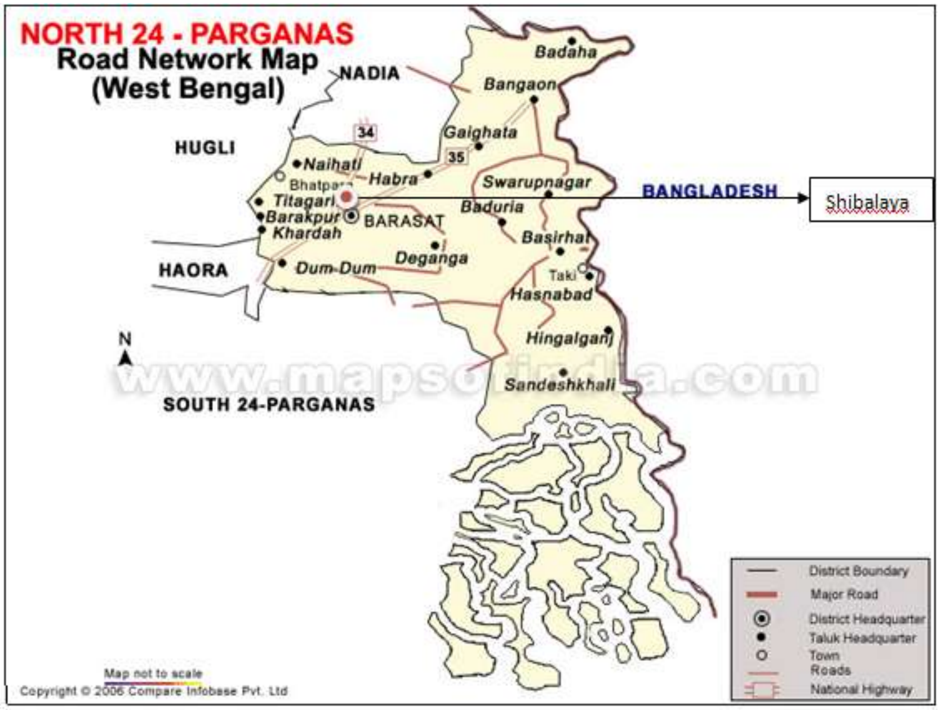


Figure 19: Map showing the location of the village Shibalaya, North 24 Pgs, W.B. (Downloaded from http://www.mapsofindia.com)

3.2.1.3.1 Village Shibalaya:

Shibalaya is a village in Duttapukur under Kashimpur Panchayet, Community Development Block Barasat-I, Police Station Barasat in Barasat Sadar subdivision of the district of North 24 Parganas in West Bengal. Shibalaya is bounded by the villages Randhan Gachha in the north, Dighra in the east, Kashimpur in the south and Santoshpur in the west. The ward number is 124 and BDO office is Chhota Jagulia. Post office is Kashimpur. Shibalaya occupies 2.12 sq. km. Total population is 5830. Out of the total population 3003 is male and 2827 is females (Census 2011).

The area Duttapukur is named after a family bearing the surname of Dutta. They dug a pond and supplied water for railway steam engines. Shibalaya was named after a temple of lord Shiva, which is located in front of a garden locally known as "*Burimar bagan"*. A *Kangsabanik* family who came from neighboring country Bangladesh bought three *bighas* of land and started to live here forty five years from now. Parimal Kangshyabanik was the first person to settle and then his kins and relatives came one after the other and lived at the place. After coming to this place from Bangladesh, Parimal Banik was without any job for two years. Then he started working with aluminum and iron. The tradition of working with silver is still going on. The village has eight hamlets. Out of them brass working artisans concentrates in Kangsabanik Para and Babur Bagan.

At the entrance of the village there is a temple of Lord Shiva. Most of the houses are brick built *pucca* houses, many of them encroach upon the road. The workshop is attached with the houses. The village has facility of tube well for drinking water. Water for use in craft is stored in tubs. Each house is provided with latrine and bathroom.

There are a number of primary health centers and sub-health centers. Hospital is in Duttapukur and Barasat. There are a number of primary, secondary and higher secondary schools.

For higher studies they have to go Barasat, Madhyamgram, Birati, Habra and Kolkata. Amtala market and market near Duttapukur Railway station are daily markets.

The distance of the area from the head quarter of the district i.e. Barasat is 7 km. It is 30 km from Sealdah on the Sealdah-Bongaon branch of Esatern Railway. Duttapukur is connected to Kolkata and Bangladesh by Jessore Road (NH-35). National highway 34 is connects the area with Siliguri in North Bengal. The area is well connected with nearby towns of Barasat, Barrackpore (SH-2), Habra, Basirhat. Golabari-Duttapukur-Nilgange Road connects Duttapukur to Krishnanagar Road and Taki Road. Netaji Subhas Chandra Bose International Airport is 22 km. away from Duttapukur and connected through

Jessore Road (NH 35). Developed transport system plays a vital role in the progress of the craft. They can easily send their products to the local markets as well as in Kolkata.

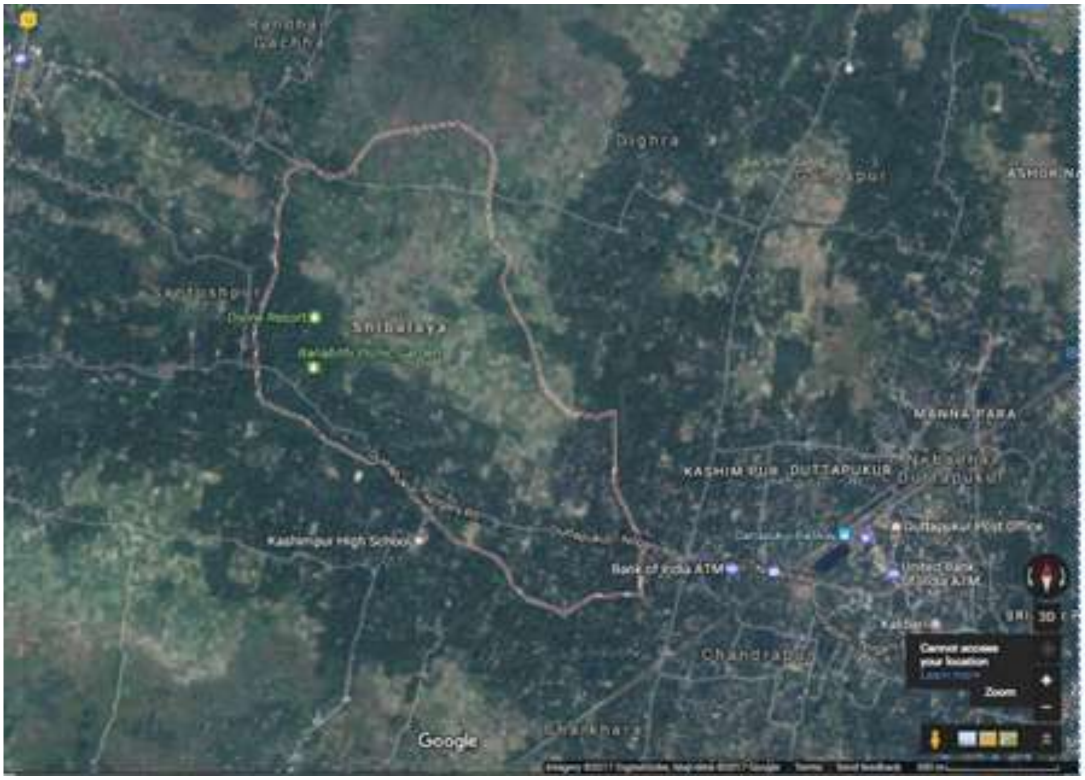


Fig 20: Bird's eye view of the village Shibalaya, Dist. North 24 Parganas, W.B. (Map downloaded from https://www.google.co.in/maps)

3.2.2 State- Odisha:

Odisha (17^{0} 49 $^{/}$N to 22^{0} 34$^{/}$N latitude and 81^{0} 29$^{/}$E to 87^{0} 29$^{/}$ E longitudes) is located on the eastern coast of India. It is bounded by the States of West Bengal on the North East, Jharkhand on the north and Chhatisgarh on the west, Andhra Pradesh on the south and Bay of Bengal on the east. The capital of Odisha shifted to Bhubaneswar from Cuttack due to the space constraint. It was formally instated on 13th April 1948 and finally shifted from Cuttack to Bhubaneswar in 1959.

Earlier this state was known as Kalinga. The state was rules by Kharavela dynasty, Gupta dynasty, Bhaumakara dynasty, Soma dynasty, Ganga dynasty. Mughals and Marathas also ruled the state. Orissa was separated from Bihar on 1st April 1936 and on 14th August 1949 the state attained its present status.

Geomorphology of Odisha is divided into four zones i.e. the northern plateau, central river basin, eastern hills and coastal plains. The coastal plain of the state stretches from the Subarnarekha River on the north to Rushikulya on the south. The plain is are narrow on the north, widest in the middle, are again narrow near Chilka Lake and further broadens on the south.

The coastal plains are drained by six rivers, which deposited silt and enlarged the area as well as made the land fertile, which is suitable for human habitation. It is also termed as a land of six deltas of the rivers Subarnarekha and the BudhaBalanga in the middle coastal plains; the combined deltas of the Baitarani, the Brahmani and the Mahanadi on the south coastal plains (The Rushikulya plains).

The eastern hilly region of Odisha covers about three-fourths of the area of the State. This region is a part of Indian peninsula. The valleys are dissected by the Rivers Baitarani, Brahmani, Mahanadi, Rushikulya, Vansadhara and Nagavali respectively. The river valleys are fertile and thickly populated. The elevation ranges from 610 to 1,068 meters. The elevation of rolling uplands is lower than the plateaus, which vary from 153m. to 305m.

The State is gifted with vast mineral deposits like coal, iron-ore, manganese-ore, bauxite, chromite, etc. The economy of the state is also being richer with the exportation of minerals deposition like chromite, coal, dolomite, iron-ore, manganese and bauxite. These mineral resources played a major role for the development of industrial units in the state.

Odisha has a mild winter and hot summer. The rainfall is widespread in Odisha. There are two monsoons i.e. the southwest monsoon and northeast monsoon. It helped to grow forest in the state (about 30.3 percent of the total area). Bhuiyas and Gonds are the

original inhabitants of Odisha. A number of scheduled tribes are distributed in different parts of the state.

The progress is noticed in irrigation. It helped for development of agriculture. Rice is the primary crop and also staple diet of the state. About 80% of the people living in the rural areas depend on agriculture. Other important produces are pulses, oil seeds and jute.

There are a number of small scale industries like traditional cottage industries, handloom silk, coir production, filigree work and brass-bell metal work (Bhatt 2008, Census of India 2011).

3.2.2.1 District -Khordha:

The district Khurda was separated on 1st April 1993 from earlier Puri district. Earlier Puri district was divided into 3 districts viz. Puri, Khurda and Nayagarh. The district name was changed to 'Khordha'in the year 2000. Khordha is the district headquarters situated on N.H. 5. In earlier times the place was formerly known as Kurada which means "foul mouthed". The district is bounded by Cuttack district in the north, Puri district in the South, Ganjam and Nayagarh district in the west.

There were 7 Tahasils, 14 police stations, One Municipal Corporation, One Municipality, three NACs, and two Census Towns, 152 Gram Panchayats and 1551 villages (Census 2011). During 2001-2011, three new tahasils, viz, Balipatna, Balianta and Chilika were created vide notification no. DRC-11/08-14913/R & DM, dated 29.03. 2008. Seven new police stations were created viz., Khordha Sadar, Nandankanan, Airfield PS, Uttara, Tamando, Nirakarpur and Mancheswar.

Khordha is the first urbanized district in state having 48.16 percent of its population live in urban areas. Khordha is 1st densely populated district in the state in

terms of population per Sq. Km. Oriya, Hindi and English are the main language spoken in the district. The primary religious faiths are Hinduism.

Table 6: Important statistics of the district Khordha, Odisha (Source: District Census Handbook, 2011)

Categories of population	**Male**	**Female**	**Total**
Population	11,67,137	10,84,536	22,51,673
Rural Population	5,95,809	5,71,548	11,67,357
Urban Population	5,71,328	5,12,988	10,84,316
Literates	9,57,515 (91.78%)	7,92,421 (81.61%)	17,49,936 (86.88%)
Scheduled Castes	1,51,528 (12.98%)	1,45,944 (13.46%)	2,97,472 (13.21%)
Scheduled Tribes	59,094 (5.06%)	55,957 (5.16%)	1,15,051 (5.11%)
Total Workers	6,45,880 (55.34%)	1,46,313 (13.49%)	7,92,193 (35.18%)
Workers in household industry	29,930 (4.63%)	9 ,541 (6.52%)	39,471 (4.98%)
Area (in sq Km.)	2813.00		
Sex Ratio (Number of females per 1000 males)	929		

The present Khordha area was once heavily populated by the Savaras, who are still found living in different parts of the area. The History of Khordha district is closely associated with the history of Puri district. Somavamsis replaced Bhoumakars around middle of the 10th century A.D. Yayati-2, Mahasiva Gupta was the first Somavamsi king and his son Udyot Mahabhava Gupta were great temple builders and the Lingaraj temple at Bhubaneswar has been attributed to them. Other legendary temples like Brahmeswar, Mukteswar and Rajarani temples were constructed by the Somavamsi kings in Bhubaneswar. Khordha got its importance when the first Raja of Khurda dynasty, Ramachandra Deva made his capital there during the last part of the 16th century A.D. The Bhoi kings lived in the foot of Barunei hill, which is about 1.6 Km to the south of the town. This site was selected because it was protected on one side by the Barunei hill and by dense jungle on the other. The fort is now completely destroyed and a few traces are remaining here and there as the remnants of past glory.

In 1568 A.D. Ramachandra Deva-1 declared himself tRaja of Khurdha. In 1592 A.D., he was recognized by Manasingh as the successor of the former Gajapati as well as the controller of the Jagannath temple at Puri. Odisha was occupied by the Marhattas in 1751 A.D. In 1760 A.D. Narayan Deva, the ruler of Khimidi attacked the Khurda kingdom, but Birakishore Deva was able to conquer him with the help of the Marhattas. For this event a portion of his territory including Purusottam Kshetra was taken away by the Marhattas. The British occupied Orissa in 1803 A.D. Mukunda Deva-2, Raja of Khurda at the beginning helped the British, but later on became revolted against the new Govt. with the eleven Rajas. Afterward the Raja was defeated and his territory was confiscated.

The Paiks of Odisha revolted against the maladministration and economic extortion of the British Govt in 1817 A.D. They were not well equipped against the British arm. As a result they were defeated and Raja Mukunda Deva died in captivity in November 1817 A.D. He was the last king of Khurda and his successors came to be known as the Rajas of Puri.

The geography of the district is characterized by the stretches of flat fertile land, suitable for rice cultivation intermingled with small patches of forests, which mark the beginning of hilly tracts. Barunei hill is 1003 ft. high. A large portion of the hill is covered by reserve forests, where valuable timber of teak is found.

Mahanadi is the important river flowing along the northeastern boundary. The eastern part of the district is drained by small rivers. There is a perennial stream at Kedara-Gouri in the Bhubaneswar town. Cultivation is the primary source of livelihood of the people. Important crops are paddy, wheat, ragi, green gram, black gram and sugar cane.

The district is devoid of any major industry. However small scale industries are found like stone carving, textile, pottery, horn work, metal work (brass and bell metal), silver filigree. Famous handicrafts of the district are purchased as souvenirs from local market.

Bhubaneshwar is the capital of Odisha, popularly known as “Temple City of India”. There are a number of temples which have archaeological importance namely Bharateswar (c. 6th century A.D.), Parsuraeswar and Swarnayaleswar (c. 7th century A.D.), Vaital (c. 8th century A.D.), Mukteswar (c. 10th century A.D.), Rajarani and Lingaraj (c. 11th century A.D.), Ananta Vasudeva (c. 13th century A,D.). The places of interests are Orissa State Museum, tribal Research Museum, Dhauli, Pipli, Konarak, Khnadagiri, Udaygiri and Nandankanan.

Fairs and festivals are celebrated throughout the year. Important festivals are Sivaratri, Khandagiri Mela, Ramanavami, Chandan Jatra and world famous Ratha Jatra.

The district has well developed facilities for education. There are number of primary, secondary and higher secondary schools, Arts and Science colleges, Engineering colleges, University of Agriculture and Technology and Utkal University.

The district is well connected with other parts of the country both by railways and highways. Khurda Road is a junction station on the Howrah-Madras route of South-

Eastern Railway is 7 miles from Khurda town. The Calcutta-Madras National Highway passes though the town. Airport is in Bhubaneswar connected with Delhi, Kolkata, Vizag and Hyderabad. Different parts of the district are connected with motorable roads with inter-state and intra-state bus services. National Highway No. 5 passes through the city (Bhatt 2008, Census of India 2011).

Figure 21: Map showing the location of the village Rathijemapatna in Khordha district of Odisha.

(Downloaded from http://www.mapsofindia.com)

3.2.2.1.1 Village Rathijemapatna;

Village Rathijemapatna ($20^0 20^/$N, $85^0 86^/$E) is situated near Balkati under Pratapsasan Gram Panchayat, in Balianta police station in Khordha sub division in Khordha district of Odisha. Post office is in Balkati and Community Development Block is in Balianta. The River Daya also flows parallel to the village. The village is bordered by Baichua road at the west parallel to the village, Balkati at the south, Canal Road in the east and Bhagabati temple in the north. The meaning of Rathijemapatna in Oriya is "Mother of Warrior". The village is quite old. According to local legend first settlers in the area were Kansari during the rule of Pratap Rudra, the King of Odisha.

The area is situated on the alluvium plain of the river Mahanadi. Soil of the area is sandy in nature and reddish in colour. It is not sticky during rainy season. Soil from the bank of the river is used in brass casting. The village is surrounded by barren lands. Earlier the land was suitable for agriculture but agriculture is not possible at present. The land at present is saline because of past flood. The village has scenic beauty as it is located at the bank of the river. Green plants and bushes are found in open areas.

Village road is curved out from the Baichua road, which is connected with Banamalipur Road towards Uttara Bus Stop (2.1 km.) of Highway no. 316. Village pathways are not metaled and turn muddy during rainy season. Houses are situated by the side of the village roads. Houses are arranged in linear fashion with front parts encroaching upon the road.

Village Rathijemapatna is divided into five hamlets i.e. Asighara, Tirishighara, Charimonia, Nuashahi and Horizon Sahi. Kansaris are found in all the hamlets except in Horizon Sahi. Kansaris live with the other caste groups by social set-up, where most of the artisan families reside principally on consideration of occupations and not of caste. Village shrines are present in all of the hamlets. Most of the houses are *pucca* brick built. *Kutcha* /mud houses are also found with mud walls and thatched roof. Workshops are attached with the houses. These are not open but closed with tiled roofing.

Tube wells and wells are the sources of water in the village. Villagers enjoy the education and health facilities. There are two primary schools, four higher secondary schools in the area. College is in Balkati. Hospital is also in Balkati. Post Office, Petrol bunk, ATM, Bank are in Balkati. The villagers connect with highway by motorable roads. There was no direct bus service from the village. Lingaraj Temple Road Rail Way Station (7.4 km.), Bhubaneswar Railway Station (15 km.) are the very nearby railway station to Rathijemapatna. Nearby airport is in Bhubaneswar.

Nearby market of the village is Balkati, where they sell their products. The products are also sold in Uttara and Bhubaneswar market. As the district is famous as pilgrimage centre brass objects have demand for token gift. There are lots of temples in the district which require the brass objects for performance of ritual activities.

Fig 22: Bird's eye view of the village Rathijemapatna, Dist. Khordha, Odisha (Map downloaded from https://www.google.co.in/maps)

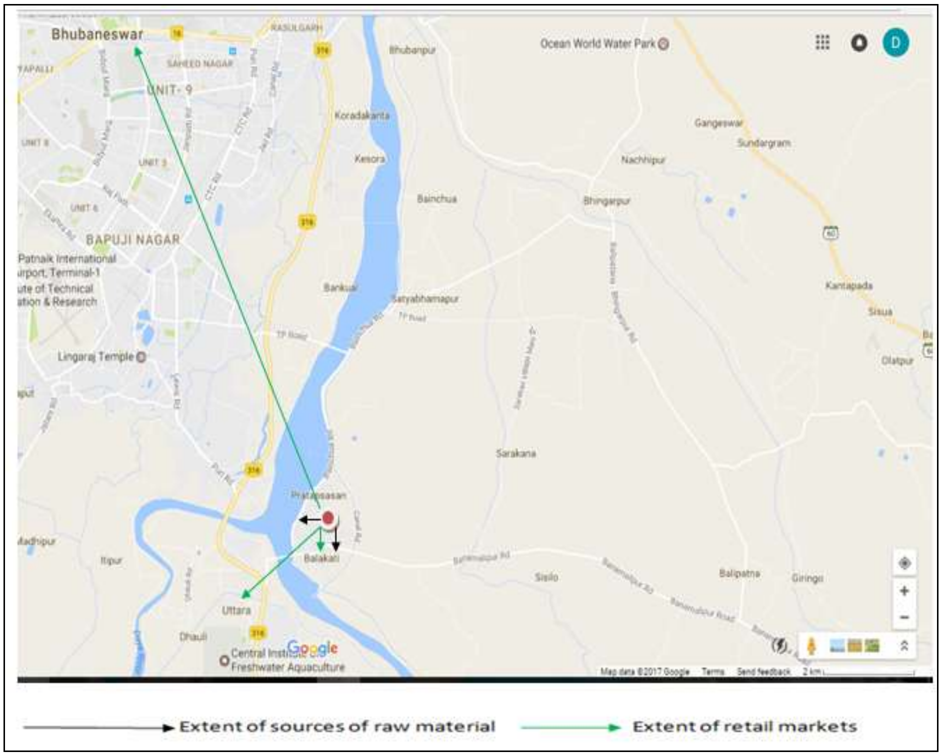


Figure 23: Map showing the extent of retail markets and sources of raw materials in Rathijemapatna, Khordha, Odisha.

(Map downloaded from https://www.google.co.in/maps)

3.2.2.2 District- Dhenkanal:

The district of Dhenkanal is centrally located on the Geo-political map of Odisha. The district is boundary of Keonjhar in its north, Cuttack on south, Jajpur in the east and Angul in the west. Total area of the district is 4597 sq.kms. The district headquarters is in Dhenkanal. The main languages spoken in the district are Oriya and Bengali. Hindus are predominant whereas people belonging to other religious groups like Muslims, Christians, Sikhs, Buddhists and Jain are also found.

Table 7: Important statistics of the district Dhenkanal, Odisha. (Source: District Census handbook, 2011)

Categories of population	Male	Female	Total
Population	6,12,593	5,80,218	11,92,811
Rural Population	5,51,326	5,23,979	10,75,305
Urban Population	61,267	56,239	1,17,506
Literates	3,65,817 (71.00%)	4,64,093 (86.18%)	8,29,910 (78.76%)
Scheduled Castes	1,15,324 (19.88%)	1,18,755 (19.39%)	2,34,079 (19.62%)
Scheduled Tribes	81,178 (13.99%)	80,878 (13.20%)	1,62,056 (13.59%)
Total Workers	4,35,533 (36.51%)	3,40,552 (55.59%)	94,981 (16.37%)
Workers in household	12,638 (3.71%)	4 ,674 (4.92%)	17,312 (3.97%)
Area (in sq Km.)	4452.00		
Sex Ratio	947		

The district owes its name from headquarters town. There is also belief that Dhenkanal town has been named after the Savar chief named Dhenka who formerly ruled over the area. Dhenkanal has been gaining popularity as a famous religious site for a period of over 100 years. It became one of the developed districts of Odisha with flourishing economy and rich socio-cultural parameters.

The district is constituted of two states Dhenkanal and Hindol. Very little is known about the history of Dhenkanal before Christian era. As per a Nasik inscription the

territory around the Malaya Mountain was included in the empire of the Satavahan king Goutami Putra Satkarni, who ruled in the Second Century A.D.

However the history of the district can be studied from the time of the Bhouma Empire in 736 A.D. which extended from the district of Midnapur (W.B) in the North to that of Ganjam in the South and up to Bouda-Khandmals in the west. A branch of Bhanja kings was ruling over the western parts of the district in the eighth century A.D. Then the Sulkies ruled over an extensive territory known as Kodalakamandala. Kullastambha-I enlarged the territory after subduing the Savar Chief named Dhekata and assumed the title of Vikramaditya.

The Sulki Dynasty continued to rule till 9th century. The history of Dhenkanal tells that the area was under the rule of various kings and chiefs belonging to various dynasties. The Afghans occupied Orissa In 1568 A.D. During the rule of Suryavamsis and Bhois some feudal states developed in this region and the state of Dhenkanal was under the rule of the kings of Bhoi dynasty.

In the thirties of the twentieth century Prajamandal was formed in different states to protest against the feudal rule. In Dhenkanal 11 people were killed by police firing in 1938-39. There was a support of Indian National Congress and All India States People's Conference.

The ruling family of Hindol belonged to solar dynasty and summoned from the Khemidi region of Ganjam during 1553 A.D. to 1906 A.D. They enlightened the material condition of Dhenkanal.

The district played an important role in the August movement in 1942. The district played an important role in freedom fighting. After independence of India the states of Dhenkanal, Hindol, Talcher, Pallahada and Athmallik merged with Orissa in 1948. Dhenkanal and Anugul were two separate districts with one combined office located at Dhenkanal. In 1992 the Government of Odisha divided the erstwhile Dhenkanal district into two districts Dhenkanal and Anugul vide Govt. of Odisha notification No. DRC-44/93-14218/R dated 27.03.1993.

Geomorphologically the district has two broad divisions. First is the hill ranges stretching from Athamlik in the southwest to Hindol in the adjoining Angul districts of running parallel to the river Mahanadi. Second is the valley of river Brahmani lying between the two hill chains, forming the central part of the district. The district has abundant forest resources.

Primary rivers of the district are Mahanadi and Brahmani. The river Mahanadi flows at the southern border of the district. The river Brahmani divides the district into two halves. The tributaries of the river Mahanadi like Karandi jore, Ghoser jore, Sindor jore, Nalia jore, Sapua and the tributaries of Brahmani like Mankara, Samakol, Ramiala, Tikra, Singada and Naigra provide drainage facilities in the district.

Various types of soil are found in different parts of the district. These are as follows:

Alluvial soil: This type of soil is found in all river valleys, suitable for growing sugarcane, tobacco, paddy, vegetables and fruits.

Red loam soil: This type of soil is found in the hilly slopes, suitable for cultivating groundnuts, cotton, sweet potato, orange and lemon.

Sandy loam soil: This is found in patches throughout the district. Rabi crops and vegetables are grown on it in rainy season.

Gravelly soil: This is found in hill slopes favourable for growing mango and jack fruits.

Loam soil: This is found throughout the district favouarble for cultivating of paddy and *mung*.

Dhenkanal district has a modest climate with high humidity during summer and cold winter months. Primary crop of the district is paddy. Others include oilseeds and pulses. The district also depends upon fishery. Beside natural sources nursery for fishery are developed. The live stock animal of the district consist of cattle, buffalo, sheep, goat and poultry. There are a number of livestock centres, natural breeding centres, veterinary dispensaries, veterinary hospitals and dairy units.

Common species found in the district are Sal (Shorea robusta), Asan (Termin alia tomentosa), Aonla (Emblica officinalis), Bahada (Terminalia belerica), Gambari (Gmelina arborea), Giringa (Guazuma tomentosa), Harida (Terminalia chebula), Jamu (Syzygium cumini), Kendu (Diospyras tomentosa), Kumbhi (Careya arborea), Kurum (Adina cordifolia), Kusum (Schleichera oleosa), Piasal (Pterocarpus marsupium), Sisoo (Dalbergia sisoo), Palasa (Butia monosperma), Ashoka (Saraca indica), Champa (Micheliia champaca), Krushnachuda (Delonix regia), Simul (Bombax mala baricum).

The district has rich mineral sources. Important minerals of the district are chromite, mica, graphite, kynite, china clay and coal. The district is industrially backward. There are a number of agro-based, chemical, electrical, ceramics and forest based small scale industries developed in the district. Paddy, asbestos and wood is main exported materials of the district.

The district is covered with dense forest and preserves colourful wild lives. In wood lands elephants, tigers and other species of animals and birds are found. Crocodiles are found in the rivers.

There are number of tourist spots in the district. The district is also rich in archeological findings. Kapilas is an ancient temple of Lord Shiva on the Kapilas Range, Joranda is famous for “Mahima Dharma”. There are number of temples constructed from 1700 AD to 1800 AD.

The main festivals observed by the people of this district are Ratha Jatra, Dol jatra, Shivaratri, Chandan Jatra, bali Jatra and Durga Puja (Bhatt 2008, Census of India 2011).

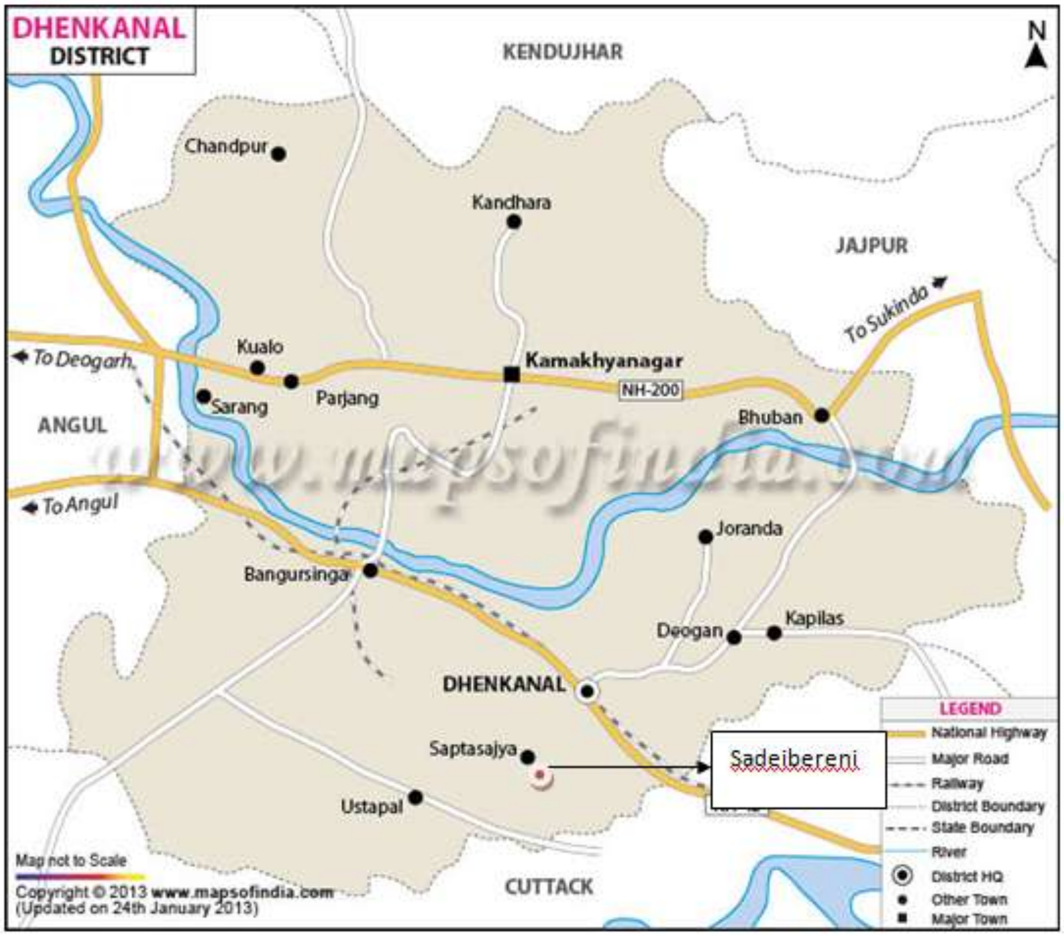


Figure 24: Map showing the location of the village Sadeibereni in Dhenkanal district of Odisha.

(Downloaded from http://www.mapsofindia.com)

3.2.2.2.1 Village Sadeibereni:

The village Sadeibereni ($20^0 34^/$N, $85^0 35^/$E) is located in the plateau area covered by Saptasajya Hill forest at the west, Dhenkanal forest at the north, Bahukhai hill forest at the northeast, Gurudijhati hill forest at the southwest. The village is under the jurisdiction of Police Station Dhenkanal Sadar, Sub Division Dhenkanal in Dhenkanal district of Odisha. Post office is Saptasajya. In the western side of the village there is famous

Saptasajya hill with picturesque background. The village is located at the right side of Saptya Sajya Road, which is connected to the Dhenkanal market by motorable road. It is 11 to 12 km far from Dhenkanal town. The village is bordered by Govidapur village and Khuntuni in the east, Dhenkanal at the north, Talabasta at the south and Saptasajya in the west.

Sadeiberni is a multiethnic village inhabited by castes and tribal people. The village is divided into five hamlets (*Sahi*). These are Sadeiberni, Nabajibanpur, Puttu Sahi, Guri Sahi, Noi Sahi. Brass artisans are concentrated in the village Nabajibanpur Sahi. Guri Sahi and Noi Sahi are inhabited by Juang, Puttu Sahi is inhabited by Shabars. The inhabitants of Saediberni Sahi are composed of different caste groups. The artisans of Nabajibanpur belong to Ghantara caste and live with other communities by maintaining symbiotic relationship. Juangs of the village supply wax and fuel wood to the artisans. Ghantara also work as agricultural labour in the land of other caste people of Sadeibereni village.

According to local legend they migrated from Malkangiri of Odisha long ago. Earlier they were nomadic move from one place to another. They stayed at one place for a few days and primarily were engaged in repairing of metal utensils or ornaments of the local people. Government took initiative to settle them in this area with naming of the hamlet Nabajibanpur.

The village pathway curved out from the main road i.e. Sapta Sajya Road. Houses are distributed in linear fashion in Sadeiberni and Nabajibanpur Sahi, however in Guri Sahi and Noi Sahi they are not in linear fashion, rather dispersed. At the entrance of Nabajibanpur there is a village shrine, worshiped by the artisans. Houses of artisans are *kutcha*/mud houses with thatched or tiled roofing. The village road is metaled and artisans carry out their craft related activities sitting on this road. Sometimes they take meal on the road. Each house has a small verandah in the front of the houses with small *chulha* oven for cooking. These are also used for casting of metal during rainy season and in hot summer. Otherwise casting is generally performed at the back sides of the houses. Nabajibanpur is devoid of toilet and latrine facilities.

Fig 25: Bird’s eye view of the village Sadeibereni, Dist. Dhenkanal, Odisha (Map downloaded from https://www.google.co.in/maps)

The village is surrounded by cashew-nut trees and agricultural land. Land belongs to caste people and brass artisans also work as labour in the field. Forest is about five kilometers from the village. Fuel for melting brass is collected from the jungle. Mainly women gather dry branches and brushes. Earlier the tribal people provided them with bee wax but now a days it is very expensive and chemical wax are used by the artisans. Fuel wood is usually supplied by Juang and Sabar tribe in exchange for cash. The stream Ghantei is flowing from west to east direction by the side of the village. It originates from the Saptasajya hill. The water of the river is used for bathing and washing. Drinking water is taken from tube well.

The village has a picturesque situation in the valley of mountain tracts surrounded with paddy fields. The mountain is covered with forest, which has wild animals. Venturing into the forest aftr dark is considered to be dangerous. In day times zips are

available from Dhenkanal to Shankarpur in Sapta Sajya road. It provides the artisans with facilities for bringing in raw material and carrying the objects to distant market place. The buyers, mainly middle men, can easily come by bus or car to the village for business.

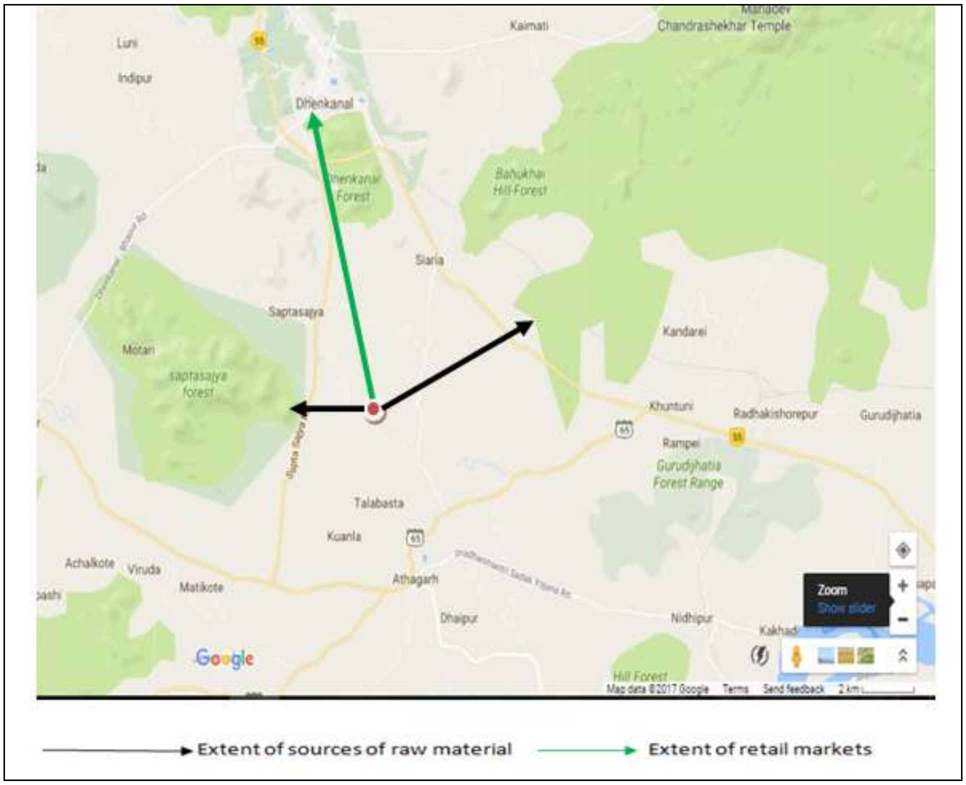


Figure 26: Map showing the extent of retail markets and sources of raw materials in Sadeibereni, Dhenkanal District, Odisha

(Map downloaded from https://www.google.co.in/maps)

Daily market is present at the entrance of the village. Electricity facility is available in the village but not in all the houses. There is a primary school in the village. Saptasajya High School is about 3 km from the village. There is no such health centre or hospital present in the village. Only a veterinary hospital is present inside the village. They have to depend on medicinal plants and quack for curing of diseases. There is a cooperative society present in the village.

3.3 Chapter summary:

The area selected for the present study is eastern India. It is mainly composed of States of Bihar, Jharkhand, Odisha and West Bengal. A total of eight clusters of brass crafts are studied. Out of these, six clusters from West Bengal and two clusters from Odisha were selected for the present study. Out of six clusters of West Bengal, two are from Berhampore in Murshidabad, three in Bankura district and one in the district of North Twenty Four Parganas. In Odisha one cluster in Khordha district and one cluster in Dhenkanal district were taken into account.

Among the clusters variation is noticed in the district level as well as state level. Khagra and Kunjghata are famous place of brass work in Baharampur in Murshidbad district. These places are within the municipal area and located almost near to the market places. So they get better opportunity for selling and delivery their products. On the other way for getting facilities of education and other training they are shifting to other occupation rapidly. In case of Shibaloy in North Twenty Four Parganas they adapted new technology of making lighter materials and the numbers of artisnas are increasing day by day. The settlement pattern and structure of workshop is more or less same.

In Bankura out of three clusters, two are in Bishnupur and one in Bikna. Kamar para and Kaity Para are two clusters of Bishnupur. Both these areas are within the Bishnupur Municipality. These places are also adjacent to the market place and enjoy the civic facilities including education. They have better salaried job opportunity and are shifting to other occupations day by day. In case of Bikna Shilpadanga more people are attracted to lost wax process. They practice indigenous method of lost wax process. The geo physical setting of the areas permits them to continue the work. There is facility to get soil and fuel at minimum costs. Geo physical setting of Bishnupur and Bikna are different. Bishnupur is in township and Bikna Shilpadanga in rural background. The settlement pattern is also different. The houses of Bikna are not in planned way but are rather scattered. On the other hand houses of artisans in Bishnupur are arranged in linear fashion in a planned township. The artisans of Bikna Shilpadanga live as a separate unit

with fortification which detach it from the main Bikna village and in Bishnpur artisans live with other castes in a particular social set up.

In Odisha Rathijemapatna in Balkati in Khordha district is an age old cluster of brass artisans. They practice brass casting for a long period of time. Artisans of Rathijemepatna have also the facility of education and facility for other jobs and they rapidly shifted to other occupations. In case of Sadeberni they live in comparatively remote area and far from the town ship. They did not get all the civic amenities. Like Bikna Shilpadanga in Bishnupur they also live as a separate unit known as Nabajibanpur, which is also detached from the main Sadeiberni village. The geophysical set up of Sadeiberni permit them to access the natural resources of soil, wax and fuel wood required for their craft.

It is clear from the above discussion that brass artisans were settled near the market place and engaged to produce brass utensils. The artisans who practice lost wax process of brass casting settle in comparatively rural background for availability of raw materials they need for the craft. Artisans living near the township enjoy better civic amenities than the artisans who practice lost wax process of metal casting and live far from the township. So it may be said that location and geophysical setting of an area is one of the important aspects of flourishing of the craft in a particular social set up. Artisans who are engaged in making brass utensils have high position in the society and live with other caste groups. On the contrary artisans who practice lost wax process of metal casting live in a separate unit detached from the main villages.

CHAPTER IV

4. SOCIO-ECONOMIC PROFILE OF THE STUDIED POPULATION

Brass and bell metal artisans belong to different caste groups namely Kansari, Tambara, Thatari, Kharaura, Sithulia, Ghantara in Odisha (Mohanti 1993). In West Bengal they belong to caste groups namely Kangsabanik, Karmakar and Dhokra Kamar (Mukherjee 1978). Though they belong to different caste groups, but practice brass work at present.

Life of the brass working communities is influenced by the craft. They live in a particular area by maintaining the relationship with other groups through the craft. Variation is not only found in the technique of brass making and distribution system of the products, but it is also noticed in population composition. Population of brass artisans in different villages and township in eastern India have been considered for the present study. For present study the following parameters are considered:- (i) family, (ii) age, (iii) sex, (iv) educational qualification, (v) marital status and (vi) occupational pursuits. As brass working group live with other communities so it is important to study the other communities with whom they live in a particular social set up.

4.1 Population composition in different clusters (Table No. 8):

Sample population was selected from six clusters of brass artisans. Out of them four are from West Bengal (Berhampore, Shibalaya, Bishnupur, Bikna Shilpadanga) and two are from Odisha (Rathijemapatna and Sadeibereni). Traditional artisans (practicing and non-practicing) as well as other communities who engage in the craft have been taken into account for the present study.

Total 1049 families were taken as sample. Out of total, 556 families from West Bengal and 493 families from Odisha have been taken into consideration for the present work. Total 72 families were studied from Berhampore cluster. In Shibaloy 307 families were taken into account and in Bishnupur 129 families were surveyed. Total 48 families practice Dhokra casting in Bikna Shilpadanga in Bankura.

In Odisha total 493 families were surveyed. Out of these, 410 families from Rathijemapatna in Khordha district and 83 families from Sadeibereni in Dhenkanal district of Odisha were studied.

Total population studied is 5259. Out of this 2628 from West Bengal and 2631 from Odisha were taken as sample. Out of the total sample population of West Bengal, 305 from Berhampore, 1473 from Shibaloy, 576 from Bishnupur and 274 from Bikna Shilpadanag were taken as sample. Out of the total sample from Odisha, 2286 are from Rathijemapatna in Khodha district and 345 from Sadeibereni in Dhenkanal district. (Table no. 8).

Brass artisans live with other caste groups and also with tribal groups in some areas. The artisans of Berhampore in Murshidabad district live with other caste groups namely Jele, Jugi, Moira, Teli, Gop and Swarna Banik.

In Shibaloy, North Twenty Four Parganas brass artisans belong to Kangsabanik caste. They live with the other caste groups namely Brahmin, Kayastha, Baishya, Namasudra, Poundra, Kumor, Teli, Napit. Muslims are only found in this village. However in Bishnupur in Bankura district of West Bengal, Karmakar lives with other artisans like Tanti (weavers) and Sankhari (conch shell workers), but in separate hamlets.

The Dokra Kamars who practice lost wax process of metal casting live in a cluster in Bikna Shilpa Danga in Bankura district of West Bengal. They live as a separate unit totally detached from the village Bikna, which is multiethnic in nature.

In Odisha the scenario is more or less same. In Rathijemapatna in Khordha district brass artisans belong to Kansari caste. Kansari dominates over the other castes likely

Goudo, Khandaita, Bania, Dhoba, Kumbhara, Teli, Rangani, Barika, Guria, Kachera, Pradhan, Thoria and Bhoi.

Sadeibereni in Dhenkala district of Odisha is a multiethnic village composed of different caste groups like Bina, Teli, Guria, Sunri, Gopala, Mali, Bania, Chasa, Barika and Kaibartta. The brass working caste of Sadeibereni is known as Ghantara. They live in separate hamlet known as Nabajibanpur. Tribal groups including Sabar and Juang also live in separate hamlets of the village. There is interaction among the different caste groups. It is important to understand nature of contact of the brass artisans with other groups. In rural areas the picture is very promising. In dokra casting wax and fuels are necessary items which are provided by the tribal groups. In other areas brass artisans sell their products to other communities. There are some products which are used by particular communities living in the area. They also have to depend on other groups for business capital with high rate of interest. As the artisans are distributed over a wide area they can capture their own market.

4.2 Individual:

Society is composed of sum total of individuals. Cumulative pattern of personality of a group make up the growth of culture complex (Benedict 1934). Individuals are the representative of the total individual of a group of population. Each individual of a group has certain norms and values influenced by the cumulative behavior of the community. Although the brass working communities maintain his own individuality in terms of the craft and traits related to the craft, they also adapt themselves to the requirements of the communities they served. Artisans leave their mark on their product. It is also the mark of individual personality and tradition. Classification of population begins with an individual and numbers of individuals compose a family, which is the smallest unit of a social system.

4.3 Family:

Family plays an important role in economic cooperation, social organization and ritual performance among brass working communities. For present study members having common hearth and the constituent members who are related either by consanguine or in affinal basis are considered as family. Family size is calculated on the basis of persons living in a household sharing a common hearth. Family sizes vary from single nuclear family to extended family. Classification of family size varies on the basis of frequency of persons present in a family. The classification is as follows (Shah 1973):

a. Small - One to three members present in a family.
b. Medium - Four to six members present in a family.
c. Large - Seven to nine members present in a family.
d. Very large - Ten and more than ten members present in a family.

Present study shows that medium sized family is dominant over others both in West Bengal and Odisha. The frequency of medium sized families are 54.17 % in Berhampore (Table no. 9.1), 51.47 % in Shibaloy (Table no. 9.2), 49.61 % in Bishnupur (Table no. 9.3) and 62.50 % in Bikna (Table no. 9.4). In Odisha medium sized families are also dominant (58.78%) in Rathijemapatna (Table no. 9.5) and 59.04% in Sadeibereni (Table no. 9.6). Very large family has the lowest frequency both in rural and urban areas. In Sadeibereni very large family is not found. Small size families have more or less same frequency in all the studied areas (36.11 % in Berhampore, 32.25% in Shibaloy, 36.43 % in Bishnupur in West Bengal and 34.94 % in Sadeibereni, Odihsa) however in case of Bikna in West Bengal and Rathijemapatna in Odisha the frequency is very low i.e. 14.58 % and 16.34 % respectively (Table no. 9.1, 9.2, 9.3, 9.4).

Family size reflects the economic status of the members. As there is need of labour, the members of joint families can help in different stages of production as well as minimize the labour charges hired from the outside.

In case of Sadeiberni the low frequency of large family indicates the small production units in household devoid of collective work. On the other way it may be said that low

economic level unable to sustain the large and very large families among the brass working communities. In case of Baharampur in West Bengal and Rathijemapatna in Odisha members of the large families have contributed in laborious technology. This also has been revealed from the present study that adoption of technology also reflected in family size. In lost wax process a nuclear family can finish the total process of production without help of others. However melting, casting and beating of large brass objects require more man power, which is provided by the members of large families. As they are giving up the traditional job day by day the large families are breaking up to nuclear families.

4.4 Age and Sex:

Age and sex structure is an important aspect of the craft. In case of lost wax process male or female can carry out the whole process individually. Making of brass items is solely a work of man in other areas. Women only help in method of making of mould in Bishnupur area and operating bellow in Rathijemapatna in Odisha. They only help in the process and not directly involved in the technology.

Sex ratio (No. of females per 1000 males) of Kangsabanik of Berhampore is 749.11. However this attains higher in case of Kangsabanik of Shibaloy in North 24 Parganas i.e. 859.84. In case of Karmakar of Bishnupur the ratio is 882.35 and in Bikna in Bankura district it is 1060.15. The ratio is 943.87 in Rathijemapatna in Khordha district of Odisha and in Sadeibereni of Dhenkanal district of Odisha it is 960.22. The sex ratio indicates that the number of female is decreasing in the studied communities of West Bengal except in Bikna. The sex ratio of Bikna (1060.15) may be due to more women participation in the brass craft. In case of Odisha the scenario is improved and better than the census scenario of India (Table no. 10).

Age grouping is done primarily at the interval of 10 years. The calculation is done up to 61 years. Age-wise distribution of both male and female are also more or less similar. It is also interesting that the frequency of males and females in each caste group indicate

the enhanced population growth. The highest frequency is found in the age group 21 to 30 in the brass working population of West Bengal except Bikna. Population at Binka, both male and females percentages are higher than other population in 0-10 years of age group, where females are outnumbered than males. The structure is different in Odisha. In Sadeibereni the highest frequency is found in the age group up to 10 and in Rathijemapatna it is in the age group 11 to 20. The lowest percentage is found within the age group above 61. In Sadeibereni the frequency of aged population (above 61) is very low in case of both male and female. It may be due to prevalence of diseases like tuberculoses and breathing problem due to inhalation of smokes from metals and also due to intake of food with low nutrients.

4.5 Dependency Ratio:

Dependency ratio of the populations has been calculated. It has been observed that the dependency ratio of Kangsabanik of Berhampore and Shibaloy are more or less same i.e. 33.19 and 32.82. In Bishnupur the ratio is 30.31. In Bikna the ratio is very high i.e. 71.25. However in Rathijemapatna in Odisha it is 54.77 and in Sadeibereni the ratio is 46.80. The ratio among the brass working communities in Odisha is higher than West Bengal. It means that children and old age population are highly dependant on the active working group of each community. In case of Bikna due to high dependency rate they are involved in the craft from early age (Table no. 22).

4.6 Marital Status:

Civil condition of a population is reflected in marital status of a population. The percentage of unmarried males and females in Baharampur are 47.06% and 30.37% respectively. Percentage of married female is higher than married males. Most of the unmarried males are found within the age groups 11 to 20 (14.17%), 21 to 30 (13.53%). High frequency of unmarried female are found in the age group 11 to 20 (12.59%) (Table

no. 11.1). Table shows that the age of marriage in case of male belong to the age groups 21 to 30 and 31 to 40. However in case of females it is 21 to 30.

In case of Shibaloy the scenario is same as in Baharampur. Frequency of unmarried males (43.69%) is higher than females (29.66 %). More unmarried males are present in the age groups 11 to 20 (14.39%) and 21 to 30 (15.15%). In case of females the frequency of unmarried females in the age group of 11 to 20 is 12.92% (Table no. 11.2). However the highest frequency of married females is found in the age group of 21 to 30 i.e. 21.44%. In case of males the age of marriage is between 31 and 40.

In Bishnupur 50% of the total males are unmarried and 32.22% females are unmarried. The maximum frequency of unmarried males are found in the age groups of 11 to 20 (12.75%) and 21 to 30 (19.61%). Unmarried males in the age groups of 31 to 40 and also in the age group 41 to 50 indicate the insecurity of new job as well as traditional brass work. Higher frequency of unmarried females is found in the age group 11 to 20 (14.44%). The age of marriage of females is higher than the other areas of study i.e. 21 to 30 and 31 to 40 (Table no. 11.3). Due to insecurity in brass work the artisans are unable to arrange marriage of their daughters.

In the village Bikna the rrequency of unmarried persons both in males and in females are more or less same i.e. 49.62% and 43.97%. Most of them are found in the age groups up to 10. The age of marriage of males is 21 to 30 and in case of females it is between 11 and 20 (Table no. 11.4). They all have opportunity of brass work and both males and females are attached with the job to support their family members.

In Sadeibereni in Odisha the percentage of unmarried males is higher than unmarried females. More unmarried males are found in the age group 11 to 20 (22.45%) and 21 to 30 (15.99%). The age of marriage of males is higher i.e. 31 to 40. This also reflects the insecurity in brass work. Females got married in the age group of 21 to 30 (Table no, 11.5)

In Sadeibeerni Odisha the frequency of married females (51.48%) is higher than married males (49.43%). Unmarried are only found in the age group of 0 to 10 and 11 to

20. The age of marriage of males is generally 21 to 30 whereas females got married in early age i.e. 11 to 20 (Table no. 11.6).

4.7 Education:

Locations of neareby educational institutes have been noticed in all the areas under study. This information unfolds educational facilities for the brass communities in the study area. In urban areas of Berhampore, Shibalaya and Bishnupur in West Bengal people can easily access school and college education. In Odisha both in Rathijemapatna and Sadeibereni there are primary schools within the village. Secondary schools are within the 10 kms range.

An overall estimation is taken for educational qualification of the brass artisans under study with a view to find out any influence of education on the occupational behaviour of the group. For this purpose two parameters are taken. One is level of literacy and other is the age group. The levels of literacy taken for the present analysis are illiterate, can sign, primary, secondary, higher secondary and graduate and above. Learning to read in primary school level is up to class IV for Indian schooling system. Secondary level is after primary till school final. Higher education includes the education after school final and graduation include the three year degree course after completion of higher secondary.

Level of literacy is quite satisfactory in case of male and females in Berhampore in Murshidabad. Illiteracy is found only in the age group up to 10. In males it is (3.53%). In case of females illiteracy is also found in the age group 51 to 60 and above 60 age groups (Table 12.1). Among the males literates Secondary education has highest frequency (47.06%), Higher Secondary and Graduate levels are also found in moderate frequency i.e. 14.11 and 11.18 (Table no. 13.1). In case of literate females of Berhampore the highest frequency is found in Secondary level (43.70%). Percentages of females with Higher secondary and Graduate qualification are 15.56 and 10.37 respectively (Table no. 14.1). As they have better access to schools and colleges both males and females get the

opportunity of higher studies. The economic condition also permits for the same. For better educational background they are shifting to other occupations with better income than brass work. The educational background of the females also implies their better position in the society.

In Shibaloy level of literacy is low. Illiterate males are 13.01% and in case of females it is 18.65%. It is also notable that illiteracy is found in new generations also (Table no. 12.2). Among the literate males highest frequency is found in Secondary education (51.52%) and the percentage of higher secondary and graduate are very low that are 7.32% and 6.69% respectively (Table no. 13.2). In case of females the secondary level of education is very high (52.28%) however females with higher secondary and graduate degree area low, that are 6.75% and 3.67% respectively (Table no. 14.2). The tendency of higher education is limited. However males are also engaged in the craft from the early age.

The scenario is more or less same in Bishnupur. Illiterate males are 6.54% and in case of females it is 16.67% (Table no. 12.3). Percentage of secondary educated (42.16%) males is higher than higher secondary and graduate level (Table no. 13.3). In case of females that is 43.33% (Table no.14.3). The area is within the town and people have greater access to educational institutes, though the level of higher education is very low. It is due to their low economic background. Most of the artisans are not engaged in the craft as well as they are not well educated and also well equipped to shift in different jobs.

In Bikna literacy rate is very low. Illiterate males are 22.56% and females are 39.01% (Table no. 12.4). Level of literacy of males restricted to secondary level (21.05%) and there is not a single person within the community with higher secondary level of education (Table no. 13.4). In case of females the highest frequency is found in the primary level of education (28.36%). There is also no female with above the higher secondary degree (Table no. 14.4). It is due to low economic condition and opportunity of income from the involvement in craft in early age.

However in Rathijemapatna, Odisha literacy rate of female (22.34% illiterates) is lower than males (9.18% illiterates) (Table 12.5). Percentage of males with secondary level of education is the highest frequency (53.83%). Level of higher secondary and graduate are also very low, that are 6.38 % and 6.55% respectively (Table no. 13.5). In case of females the secondary level education is also found with the highest frequency (40.81%). However females with higher secondary level of education are 3.78% and graduate level of education are 2.52% (Table no. 14.5).

In Sadeibereni in Odisha literacy level is very low. Percentage of illiterates in males is 30.11 and in females is high i.e. 54.44 (Table no. 12.6). Among males level of secondary education is high (30.68%) and there is no male in the village with graduate degree (Table no. 13.6). level of primary education is high (18.93 %) among the females of Sadeibereni. There is no female with higher secondary or graduate degree (Table no. 14.6). The reason behind this is same as Bikna in West Bengal due to low income and practicing of the craft from very early age.

So the overall scenario of brass working communities in both the states is same. There is little trend to higher education except in the case of Berhampore in Murshidabad district of West Bengal. In case of Bikna in West Bengal and Sadeibereni in Odisha, who practice lost wax process of metal casting are in very low level of literacy. Further attempt has been made to find out the correlation of occupation with education.

The communities who engage in brass work at present have been analysed. Result shows that in Berhampore most of the artisans belong to secondary level (59.52%). Percentages of artisans with higher secondary and graduate level of education are 19.05% and 2.38%. It is also notable that there is no illiterate artisan in Berhampore (Table no. 17.1). However in Shibaloy the situation is different. Illiterate artisans (8.31%) are present there. Most of the artisans belong to secondary level of education (57.96%). The artisans with higher secondary and graduate level are 5.46% and 3.09% respectively (Table no. 17.2). In Bishnupur illiterate artisans are also present 3.85%. Most of the artisans have secondary level of education (51.92%). It implies that after completion of secondary education they were engaged in the craft (Table no. 17.3). In Bikna most of the

artisans belong to can sign category (20.51%) and primary level of education (42.31%). Artisans with secondary level of education are 28.21 % (Table no. 17.4). In Rathijemapatna in Odisha artisans belong to illiterate category (5.78%), can sign category (11.90%), primary level of education (20.26%), as well as secondary level of education (55.95%). Out of this secondary level of education has the highest frequency found among the artisans. It is also notable that artisans with higher secondary and graduate degree also present in the village (Table no. 17.5). In Sadeibereni village most of the artisans belong to illiterate category (22.86%) and can sign category (22.86%). Artisans with secondary level of education are 37.14%. No artisan is above the secondary level of education in the village (Table no. 17.6). So it is clear from the above discussion that most of the artisans are engaged in their traditional occupation after completion of secondary level of education. Interview with the artisans reveal that they have hesitation either of leaving of traditional occupations or take up new occupation as a challenge. However in case of Bikna in West Bengal and Sadeibereni in Odisha artisans also from the new generations are well adapted with traditional lost wax process of casting and without any hesitation they engage in brass work also. Sometimes they also practice dhoka casting beside other occupation side by side.

4.8 Occupation:

Making of brass and bell metal is the hereditary occupation of the studied communities. The craft of making brass objects is related to production and economy and substance system of the people related with the raft. Artisans who are at present engaged in the craft are full time artisans and their livelihood pattern is solely depends on making brass items.

It has been found in the present study that there are occupational variations within the communities. At present they are not always follow caste occupation and shifted to other occupations. Study has been made of the occupational pattern of the communities in relation to the age groups. Subsistence other than brass work are, agriculture, service,

business, daily wage labour, student and unemployed. In Berhampore 49.41 % male of the total male population are engaged with the craft (Table no. 15.1). The higher frequencies are found in the age group of 21 to 30 (11.76%) and 31 to 40 (12.94 %) (Table no. 15.1). Brass working as a hereditary occupation is practiced by 83.33% families who belong to the caste Kangsabanik. Other castes who adopted the technology are Boishya, Boiragi, Jele and Jugi (16.67%) (Table no. 20). Occupations other than the brass work include agriculture (1.18%), service (5.29%), business (11.76%), daily wage labour (1.76%), and student (19.41%) (Table no. 15.1). No female in Berhampore is engaged in any process of brass work. Most of them are engaged in household work (71.85%) (Table no. 16.1). The scenario helps to know the position of women in the society. The structure of the society keeps aside women from economic activities. This structure shows the lower position of women in the society. The per capita income of the Kangsabanik families engaged in brass work are 36 (50.00 %) in the group ≤ Rs. 2500.00 and 11 (15.28 %) in the group Rs. 2501.00-Rs.5000.00. High range of income is found in the cases families engaged in other service and business (Table no. 21).

In case of Shibaloy 53.16 % of the total male population are engaged in the craft. Higher frequencies are found in the age groups of 21 to 30 (15.03%), 31 to 40 (13.15%) and 41 to 50 (11.87 %). Rest of the population are engaged in business (12.88 %), service (2.40%), daily wage labour (1.01%) (Table no. 15.2). The scenario of female participation in the brass craft is different from Berhampore. 26.29 % of total female population is engaged in brass work beside their household work. The highest frequency is found in the age groups 21 to 30 and 31 to 40. Others are engaged in household work (43.03%), service (0.29%), business (3.67%) and student (19.38%) (Table no. 16.2). The frequency of Kangsabanik family engaged in the craft is 86.94%. 13.06 % are other caste group who had taken brass work as their occupation. They are Poundra, Namasudra, Boishya, Barujibi and Brahmin (Table no. 20). Per capita income of the families engaged in the brass work are 70 (22.80 %) in the group ≤ Rs. 2500.00 and 110 (35.83 %) in the group Rs 2501.00 to Rs. 5000.00 and 25 (8.14 %) in the group ≥ Rs. 5001.00. The frequency is low in case of other occupation (Table 21). Due to high range of income

most of them are engaged in brass work as well as members of other caste groups also adapted with brass technology here.

In Bishnupur most of the people shifted to other occupations. Only 16.99% males are engaged in brass work. Higher frequencies are found in the age group of 31 to 40 and 41 to 50. Most of the people are engaged in business (28.43%). People engaged in other occupations like service (8.82%), daily wage labour (11.11 %) and student (17.65%). Frequency of unemployment is also remarkable 916.99%) (Table no. 15.3). It is clear that people do not take brass work as their livelihood, even if the unemployed persons. In Bishnupur female participated in the craft is fund. 6.67% of the total female population engaged in making of mould for metal casting beside their household work. Most of the females are engaged in household work (64.81%). Others are in service (0.74%), business (3.33%) and daily wage labour (0.37%) (Table no. 16.3). Low economic level of the artisans forced women to take other occupation to support their family expenditure. In Bishnupur no member from other caste group who have taken the brass work as their occupation (Table no. 20). Per capita income of the families engaged in brass work is ≤ Rs. 2500.00. Families engaged in other occupations have high range of income (Table: 21). So there is tendency of leaving the traditional occupation and shifting to others.

In Bikna the scenario of occupation is satisfactory. Most of the male artisans engaged in lost wax process of metal casting (58.65%). Few of them are engaged in business (3.01 %) and daily wage labour (0.75%) (Table no. 15.4). It indicates better opportunity of brass work in the village. Labour force mainly comes from the age groups 11 to 20 and 21 to 30. Frequency of females engaged in the craft is higher (60.28%). Main labour force come from the age groups 11 to 20 (16.31 %) and 21 to 30 (19.86%) in case of females (Table no. 16.4). In Bikna almost all the families who practice brass work are Dhokra Kamar (93.59%). Only 6.41 % belong to other caste group (Table no. 20). They practice craft beside their household work. Per capita income of all the families engaged with the craft is ≤ Rs. 2500.00 (Table no. 21).

Practicing of brass craft in Rathijemapatna in Khordha district of Odisha is not satisfactory. 26.45% males have been taken brass work as their livelihood. Most of them

are engaged in other business (26.70%). Other occupations found in the area agriculture (0.51%), service (3.23 %) and daily wage labour (5.78%). Labour force mainly comes from the age groups 21 to 30, 31 to 40 and 41 to 50 (Table no. 15.5). No female is engaged in metal work in the village. Most of them are engaged in household work (68.11 %) (Table no. 16.5). In Rathijemapatna out of the total families engaged in the craft 93.57 % belong to Kansari. Rest 6.43 % had adapted brass craft as their occupation. They belong to the caste namely Khandaita, Bania, Teli, Rangani, Barika, Kachera, and Bhoi (Table 20). Per capita income of the brass workers is 25.85 % (≤Rs. 2500.00 category) and 6.10 % in the category Rs.2501.00 to Rs.5000.00. High range of income (≥ Rs. 5001) is found who are engaged in other occupations (3.90%) (Table no. 21).

In Sadebereni in Dhenkanal district of Odisha 59.66 % males are engaged in lost wax process of brass casting. Main labour force comes from the age groups 11 to 20, 21 to 30, 31 to 40 and 41 to 50 (table no. 15.6). As there are opportunity for getting the jobs few people are engaged in other occupations, in business (0.57%), daily wage labour (10.79%) (Table no. 15.6). High frequency of females are engaged in the craft is 73.37%. In Sadebereni lost wax process of metal casting is practiced by Ghantara community only (Table no. 20). No othr caste was involved in brass work in the village. They practice brass craft beside their household work (Table no. 16.6). Per capita income of all the families engaged in the craft is ≤ Rs. 2500.00 (Table no. 21).

4.9 Nature of work:

Artisans also divided into mode of work. In Berhampore 53.37 % are artisans, 11.90 % are artisan labour. Rests (34.52%) are engaged in other types of work like scraping, polishing and washing (Table no. 18.1). Out of the total artisans 65.48% engaged in shaping and casting mostly belong to the age groups 21 to 30, 31 to 40 and 41 to 50. 19.05 % are engaged in polishing of brass objects. Most of them belong to the age groups 21 to 30 and 31 to 40. A considerable number of artisans are engaged in repairing of old brass objects (Table no. 19.1).

In Shibaloy out of total males engaged in brass work 58.19% are artisan, 40.62% are artisan labour. Others related to the craft are 1.19% (Table no. 18.2). Most of the artisans are involved in all types of work including shaping and casting (98.81 %). Artisans who are expert in polishing is 0.71% and in designing 0.48% (Table no. 19.2). They do not practice the actual shaping and moulding method but they are engaged in polishing, cleaning and designing besides their household work.

In Bishnupur 82.69% are artisans and 17.31 % are engaged in related work. There is no artisans labour in the area (Table no. 18.3). All of the artisans are involved into all types of work like shaping, casting, polishing and designing. 7.69% of the artisans are expert in polishing and 1.92% artisans are expert in designing (Table no.19.3).

In Bikna Shilpadanga of Bankura district of West Bengal both males and females are expert in all types of works relating to the technology from making of mould to casting in furnace. Out of total male artisans 98.81% engaged in all types of works and 1.19 % is engaged in repairing of old objects (Table no. 18.4 & 19.4).

In Rathijemapatna, Odisha 56.59% are artisan labour and 43.09 % are artisans (Table no. 18.5). Among the artisans 99.68% artisans are able to all types of work like shaping, casting, polishing and designing. 0.32 % of total artisan groups are engaged in repairing works (Table no. 19.5). Females are not directly associated with the craft, but few of them help for operating bellow at the time of melting of metal.

In Sadebereni, Odisha all of the persons both males and females are artisans. They are expert in all types of work related to the brass craft including mould making, wax designing, casting. Sometimes casting in large scale is done by males in bigger furnaces (Table 18.6 & 19.5).

The Further combination is made on the basis of age and sex distribution. It is based on the capacity and nature of work of the artisans. Children start helping in brass work at an early age i.e. from 11 to 20 years in all of the areas except two areas. In case of lost wax process of metal casting both in West Bengal and Odisha they start to help in the work at his childhood in the age group up to 10 years. They help in every stages of work.

So they star to learn the craft from their childhood. The boys of that age group are mainly helpers and learners. However in other areas the scenario is different. They involve in making of brass objects from the age group 11 to 20. They also participate in different stages of the production but not directly in the melting of metals. The main labour forces come from the age groups 21 to 30, 31 to 40, 41 to 50. Making of brass objects by casting and beating is very laborious job. It can be assumed that the ability of making brass objects is best acquired around 40 years of age.

There is no female who participate or help in brass work in Berhampore in Murshidabd and Rathijemapatna in Khordha district of West Bengal. In Shibaloy in North 24 Parganas females start to participate from the age group 11 to 20 and in Bishnupur, Bankura it is 21 to 30 years. They participate in different stages beside their household work. In case of lost wax process females started to learn the craft from their childhood. After that females from each age group fully participate in the process of brass casting.

4.10 Social aspects of the studied communities:

Social aspects of different communities are also important to understand the different aspects of the craft. Different rituals and ceremonies practices by the artisans are related to the craft.

For the present study three communities of West Bengal and two communities of Odisha have been selected. In Berhampore and Shibaloy in West Bengal communities belong to the caste group Kangsabanik. Whereas in Bishnupur of Bankura district of West Bengal artisans belong to the caste group Karmakar. In Bikna the Dhokra kamar are traditionally engaged in lost wax process of metal casting. In Rathijemapatna in Odisha brass working is generally a hereditary craft of Kansari and In Sadebereni in Odisha lost wax process of brass casting is practiced by Ghantara**.**

4.10.1 Kangsabanik:

Kansabanik or Kansari is one of the brazier castes of Bengal, supposed to be originated from Subarnabanik. The name was derived when they started working in Kansa or bell metal. There is another view that they are a sub-caste of Kamars, who separate themselves from the parent caste and set up as an independent group. Their social position is higher and considered as a member of Nabasakh group. Brahmans take water from them (Risley 1891). According to local legend Kangsabanik gifted mirror of bell-metal in the marriage of Lord Shiva and Goddess Durga (*Parvati*). At first they were not familiar with the technology of metal. They tried to make this by separate use of fire, water and tools, but they failed. After that they prayed to Goddess Durga and she told them to set fire, water and tools closely to make brass items. Ultimately they were successful.

In east Bengal, present day Bangladesh, Kansaris belong to Saiva sect. Like other artisans they also observe the festival of Biswakarma, the mythical architect of West Bengal. Manufacturing of brass and bell-metal objects is the hereditary occupation of the Kangsabanik . Earlier times caste names were derived from different occupational groups like Lohar Kamar, Tamar Kamar, Swrana Kamar, Pital Kamar, Dhokra Kamar and gradually they separated into endogamous castes. Kansaris existed from a very long period of time and are restricted to the south-western part of Bengal. According to thirteenth century Sanskrit texts Brihatdharmapuranam and Brahmavaivarttapuranam they were ranked below the other artisan groups of Bengal. However they had improved their social rank between sixteenth and eighteenth centuries. This is due to their economic upliftment and they became merchants of their finished products and raw materials. As a flourishing industry they localized in different centres in East Bengal and West Bengal namely Saptagarm, Dacca, Nabdwip, Maldah, Murshidabad and Bishnupur. At the beginning of nineteenth century they achieved comparatively higher position than other Nabasakh castes. On the basis of their place of residence they are divided into different *gains* or sub groups like Mahmudpuri Kansari, Saptagarmi Kansari. They gradually became endogamous group and used different surnames. The Kangsabanik of West

Bengal generally claimed higher social status than the artisans who migrated from eastern and northern Bengal. Throughout the nineteenth and early twentieth century there was a significant growth of metal ware industry. In the nineteenth century Kansaris migrated from western part to eastern part of Bengal. A number of artisans of Khagra, Murshidabad migrated to Rajshahi, Dacca. Calcutta became an important centre of Kansari. They settled around Banarasi Ghosh Street and Bhowanipur. There were one thousand Kansari workers in Kansari para of Banarasi Ghosh Street in 1924. The Bangiya Kangsabanik Sammilani, Kangsabanik Patrika proves the past glory of Kangsabanik. Due to introduction of sheet metal and intrusion of other castes in the craft, the traditional brass industry fell down. A vast number of Kansaris changed to goldsmith's profession. Due to identity crisis they adopted the title of Kangsabanik (Sarkar 1994)

In the present study the brass artisans of Khagra and Kunjaghata in Berhampore in Murshidabad district and Shibaloy of North Twenty Four Parganas belong to the caste Kangsabanik. They live with the other caste groups namely Teli, Jele, Boiragi, Gop, Swarna Banik, Baishya and Jugi. They became a dominant group in the area. There was a separate place of bathing in the river, locally called Kansari Para Ghat. Brahmin takes water from their hand. So due to economic upliftment their social position was ranked higher. The artisan of Khgara claims them superior than the Kangsabanik in Kunjaghata, who migrated from Bangladesh. However in Shibalaya brass artisans live with scheduled caste and scheduled tribe groups also with Muslim community. The Kangsabanik of Khagra bears the title Das and Dutta. However the artisans of Kunjaghata and Shibaloy bear the same surname Kangsbanik. It is also worth mentioning that both the groups migrated from Bangladesh.

They are endogamous groups. Marriage within the caste is permissible. There are few cases of marriage outside Kangsabanik caste in Shibalaya, but in Khagra, Berhampore it is still prohibited. Women are not allowed to participate in the work but in Shibaloy women help in different related activities. After marriage women reside in their husband's house. Age of marriage of both males and females are higher. In Khagra women both married and unmarried engaged in household activities. As the houses are

fortified by walls the activities of women are generally limited within the household. Married women come outside with covering their head with the end part of Saree, known as *aanchal*. In case of Kunjaghata and Shibaloy it is not so rigid.

Artisans of Khagra prefer to establish marital relationship with the Kansaris distributed in adjacent districts of Krishnanagr, Nabadwip, Muragachha, Shantipur in Nadia district as well as brides are also selected from Maldah and Murshidabad districts. Whereas in Kunjaghata and Shibaloy brides are selected from Bikrampur in Dhaka district, Jessore in Khulna district and also from Faridpur districts of Bangladesh as well as Murshidabad district of West Bengal. It is also interesting that marital relationships are also established among males and females of these two areas of Kunjaghata and Shibaloy.

They follow patrilineal descent. Property and workshop is descended through male members of the family. They are divided into number of clans like Dadhirishi, Sankharishi. Clan exogamy is followed during marriage ceremony. Marriage is generally negotiated by the parents. There is ritual of exchange of gifts of beautifully decorated brass objects during marriage ceremony.

They believe in Hindu religion and worship Hindu Gods and Goddesses. Beside this some of the religious rituals are related to their craft. They worship Goddess Singhabahini in the workshop day after the worship of Goddess Kali in the Bengali month Kartik (October-November). They clean all the instruments and workshop also and worship all of these as the symbol of the Goddess Durga. Work is restricted for that day. After the immersion of Goddess Durga of the famous festival Durga Puja in the Bengali month Ashin (September-October) they start work after worship of Lord Ganesh. New account book is opened on that day, which will be used for another one year. This ritual is locally called as '*Saith*'. In Shibaloy work is usually restricted for seven days during Maker Sankranti, which is observed at the last day of the Bengali month Poush (December-January).

4.10.2 Karmakar:

Karmakar is a synonym of Kamar. They are metal working caste of Bengal and Bihar. There is popular belief that they descended from an intrigue between a woman of Sudra caste and artificer Viswakarma. They belong to Nabasakh group and divided into number of classes like Lohar Kamar, Pituli Kamars, Sarna Kamar, Ghatra Kamar, Chand Kamar, Kansari, Dhokra Kamar and Tamar Kamar. Kamars of Rarh Bengal are divided into Rana Kamar, Kulti kamar, Astaloi Kamar and Biraloi Kamar. The present studied groups of Bishnupur are Rana Kamar. They came from Mayurbhanj area of Orissa by the patronization of Malla Kings about four hundred and fifty years ago. Earlier they were experts in lost wax process and engaged in making ornaments and brass utensils (Chandra 2015). Gradually they adopted the technology of making brass utensils.

They are endogamous group. Marriage outside the caste group is prohibited. Marriage is generally negotiated by the parents. System of dowry is prevalent among them. They are also divided into number of clans (*gotra*), which are exogamous in nature. Patrilineal descent is followed. Women transformed from his father's clan to his husband's clan after marriage. After marriage they live in their husband's house. Marriage of women is generally performed after attainment of puberty. Beautifully decorated and engraved brass pitchers are gifted from groom's family to bride's family. Brides are selected from the areas of Susunia, Raipur, Patrasayar, Ajodhya, Bishnupur, Sonamukhi, Lalbazar of Bankura district and also from the adjacent districts of Bardhaman and Purulia. Women are not directly associated with the craft. Mostly married women practice of making moulds of clay for metal casting. They are engaged in household activities as not assigned to outside works.

They live with other artisan groups like weavers and conch shell workers. They also serve for these communities and vise versa. There is local committee of Kamar caste locally known as *Karmakar Soloana*. They organize different community festivals like Durga Puja and also help other families. This local body also help to mitigate problems arise within the community.

Karmakars are Hindu by religious faith. They worship Hindu Gods and Goddess. They have faith on the deity Viswakarma, who is worshipped on the last day of the Bengali month Bhadra (July-August). They clean their workshop and also clean the tools and equipments used in the craft. They also worship hammer, anvil and other tools used in the craft on that they. The offerings are sweets, fruits, flowers, molasses, cloths, Ganges water, silver ornaments and parched rice. The work is restricted on the day. Cooking is prohibited on the day and they eat parched rice with fried fish cooked in the night before the observed day. The day after the worship of the Goddess Laxmi (September-October), they do not touch their instruments. The craft is usually suspended in every Sunday.

4.10.3 Dhokra Kamar:

Dhokra Kamars are considered as a sub-caste of Kamar or blacksmiths (Risley 1981). They are folk metal artisan expert in lost was process of brass casting. They are known by various names such as Malar, Mal, Sekra and Thetri in different parts of West Bengal in the districts of Burdwan, Bankura, Birbhum, Purulia and West Midnapur. They are broadly divided into two Malar and non-Malar. The artisans of Bankura, Burdwan, Birbhum and Midnapur are Malar and non Malars are mainly concentrated in Purulia. Their craft is known as Dhokra, which was derived from the name of the community (Chakrabarty 2009).

The social position of Dokra Kamar is lower than other caste groups in the area, they lived in a separate cluster detached from the main village. Other caste groups maintain distance from them and generally do not enter into the cluster. They practice lost wax process on the courtyard. As the craft produce heaps of fired and broken crucibles the place of their residence looks ugly. Their close are also became dirty as they have to work with clay and sand.

Earlier they were nomads and roam from one area to another with their necessary tools for the craft. They stayed in an area for few days and make objects according to the

demand of the people of the area. The history told that the original homeland of Dhokra artisan is Chhotanagpur Plateau, from where they migrated to Ranchi, Chaibasa and other places of Singbhum about 200 years ago. About 150 years ago they settled in Gopalpur near Bishnupur and Rajas of Bishnupur gifted a homestead and a plot of agricultural land to them. From there they shifted to Rampur and then at present Bikna Shipadanga in Bankura district of West Bengal (Jana 2013).

They are Hindu by religion. They are endogamous group and follow clan exogamy. They are divided into totemic clans like Nag (snake), Bagh (tiger), Karkat (crab) and Kacchap (tortoise) Marriage is generally practiced after puberty. They follow Hindu marriage rituals and customs. Any senior member of barber caste can act as a priest. There is no elaborate ritual. Bride and groom are called together and bride put vermillion on the forehead of groom. After that newly married couple lives separately from their parents. Divorce, remarriage and widow remarriage is permissible in their society. Second cousin marriage is also practiced. They have marital relations towards the south Bankura bordering the Midnapur region. Whereas the Dhokras of north Bankura have marital relations over Purulia, Singbhum and adjacent areas (Ghosh 1981). In Bikna Shipadanga Brides are selected from other areas of Madanmohanpur, Bishnupur, Ptrasayar in Bankura district, Dariapur and Raniganj in Bardhaman district, Serikella of Jharkhand as well as from Odisha.

After birth of a baby, father of the baby distributes country liquor to the villagers. They follow first rice giving ceremony (*mukhebhat*) at the six months age of a baby. They generally cremated dead body and perform post funeral ceremony (*sradha*) after 15 or 30 days.

They have social punishment. If any malpractice is noticed, hair locks are cut from the head and fix it up with thread on the branch of a banyan tree.

They follow many religious rituals including Viswakarma Puja, Manasa Puja and Maker Sankranti. They worship Viswakarma Puja on the last day of the Bengali month

Bhadra (July-August). They worship the furnace, tools and equipments on that day and the work is restricted for the day.

At present they have given up their parambulating life and settled in different clusters adjacent to multiethnic non-tribal villages (Jana 2013).

4.10.4 Kansari:

There are three caste groups in Odisha practice metal work. They are Kansari, Thatari and Tambara each forming a single ‘caste cluster’ (Karve 1963). The three groups follow the same technique of manufacture of copper, brass and bell metal. They belong to Hindu religious faith and occupy an almost similar position in hierarchical order. They are representative of metal craftsmen- the Tamrakarah (Copper smiths), the Kansyakarah (Bell-metal smiths) and the Tashtakarah (one who polish the bras and bell metal wares). The use of copper was restricted to ritual use for its scarcity and created opportunity of use of brass, an alloy of copper and zinc gradually. Brass has an extensive usage for manufacturing of utilitarian objects because of its malleability and attracted the Kansari cluster. In study area of Rathijemapatna in Khordha district of Odisha brass workshop is still known as ‘Tambarasala’, which suggests that Tambara copper smiths adopted brass for making utensils (Mohanti 1993).

In 1955-56 Kansari was enlisted among Other Backward Classes (O.B.C). This status helped them raising their educational standard but does not solve the economic problem (Ghurye 1969). In 1980, they were not included in the list of other backward Classes (Cf. Report of the Backward Classes Commission, 1980).

The Kansari sub cluster includes both Tambara and Thatari. They are considered as Jala-Achala Sprushya Shudra under *Chhatisha Pataka* (Thirty three service caste series). According to *Brahmavaivarta Purana* Kansari was one of the nine children of Viswakarma, the Divine architect and a Shudra women. They had nine children namely Mali (Garland make), Kamara (Blacksmith), Sonkhakara (Conch shell carver), Tanti

(Weaver), Kumbhara (Potter), Kansari (Metal worker), Sutradhara (Architect), Chitrakara (Painter) and Swarnakara (Goldsmith) (Kramrisch 1959). Kansari and Thatari are considered as pure and respectable Shudra caste in the district of Puri, Cuttack and Balasore (Hunter 1976). The Kansari are assigned with two kinds of *seva*, ritual services in the temple of Lord Jagannath, such as, *Tamara Bishoi* and *Ghantua seva (*Mohanti 1993*)*. They are engaged in making of wide variety of copper, brass and bell metal objects in different parts of Odisha. They are endogamous group within the sub-cluster. They also have caste council and guild-like association.

Kansari are endogamous in nature and exogamy is restricted. Marriage within the same clan (*gotra*) is prohibited. Marriage is linked genealogically up to five generations in the male line descent and three generations in female line of descent is usually prohibited. Marriage of Kansari is usually restricted to an area and limited to affinal relations, which are imposed by *Thana* organization. Marriages negotiated by parents or guardians are considered as more prestigious and generally communicated by traditional match makers. They follow the patrilocal rule of residence. Brides after marriage reside in her husband's house. Childe marriage is restricted at present. Post –pubescent marriage is generally practiced. So the enhancement of age of marriage both males and females shows a progressive trend of the society. Marriage in the bride's house (*danad-bibaha*) is more expensive and considered as more prestigious than *tola-konia bibaha*, which is arranged in the groom's house. Exchange of gifts, either in cash or kind is a part of marriage. Bride-price was prevalent in earlier times and the trend is supported by payment of dowry at present. There is an elaborate ritual of exchange of areca nuts on this occasion, based on the status and position of an individual within the society. Divorce is permissible, however there are certain restrictions regarding the widow remarriage. Brides are selected both from the same and adjacent districts namely Baichua in Cuttack district; Kantilo in Nayagarh district; Sakhigopal, Chandanpur and Balanga in Puri district; Mangalpur in Jajpur district; Bhawanipatna in Kalahandi district; Berhampur in Ganjam district; Muktapur, Balipatna, Hirapur, Banamalipur and Bhubaneswar in Khordha District as well from other adjacent districts of Jagatshingpur,

Koraput and Kendrapara. Brides are also selected from Balkati and Rathijemapatna usually from different hamlets in which bride or groom reside.

They generally follow clan exogamy. The children inherit their *gotra* fromm their father. In Rathijemapatna *Kashyapa, Naga, Sarasa, Oulastra, Baghra gotras* are prevalent.

Most of the families consisted of members of two different generations. Though nuclear family dominates, lineal-joint families have not lost their influence in the society. The family is patriarchal in nature. Head of the family is a male member who looks into different matters into different external and internal matters. Kansari family is patrilineal and descent is traced through paternal line. Though property is equally shared among the sons, the eldest son enjoys some privileges.

The Kansrais of Odisha differentiate themselves from other non-kansari groups. There are close kinship bonds and various kin groups which reflect their social interaction with other groups. There are also some ritual kinship (*pritibandhu, maitra* etc.), consanguinal kinship (*ghi-khia kutumba*). There is also *Thana bhai* group, which is endogamous in nature. In the village Rathijemapatna six households of D. Moharana is included the *Thana bhai*, which are entitled to 5 *kuhas*, equal to 250 areca nuts, for their participation in marriage ceremony.

Kansari follow Hindu religious belief and faith. They worship several Hindu deities and believe in Hindu Trinity of Brahma (the creator), Vishnu (the preserver), and Shiva (the destroyer). They are aware of the *Chaturbarga* doctrine of *dharma, artha, kama, moksha*. Several rituals performed throughout the year at the household and community level controlled by Oriya Calender. The worship of Goddess Durga, is the deity of power is related to the craft. She is worshipped for four days during Dashera (September-October). Manufacturing process is suspended for those days. Tools, equipment and finished objects are worshipped (*Sajabasta*). Goddess Durga is worshipped by Kansari as their craft deity and there is believe that Goddess Durga is

intimately connected with metals. There is also believed that metals wer produced from sacred semen of Lord Shiva.

There are number of temples of god and goddess within the villages. Worship of lord Ganesh, Laxmi, Vishnu and Shiva are performed on the ordinary and prescribes day also. Lord Jagannath enjoys special awe as the state deity. Sometimes they appoint priest for worship. Earlier days there was no worship of Lord Viswakarama. Now it has been initiated in the workshop of some Kansari families.

The politico system found in village level and also outside the village level which sometimes work with the state level. Different problems in family as well as within the community are solved through this system. There are six tiers operational systems, (i) The Family, (ii) The *Thanabhai*, (iii) The *Thana Sabha* at the local level, (iv) The *Thana Sabha* at the regional level, (v) The *Mahasabha*, (vi) State level, wider politico-jural network. The village is multi-caste in nature and there is a web of relationship. There is conflicts and factions within the Kansari community and also extend beyond the caste. These are tried to mitigate through this system. Caste councils play a vital role in social control. There are punishment in the form of fines (cash or kind), excommunication (social/moral) and also corporal punishment (Mohanti 1993).

In spite of these, Kansri are dominant group composed of 71.43% of total population of the village. They live with other caste groups like Goudo, Khandaita, Bania, Dhoba, Kumbhara, Teli, Rangani, Barika, Guria, Kachera, Pradhan, Thoria and Bhoi. They serve for the other groups belonging to different caste groups. Sometimes they also depended on the other groups for their craft in terms of indebt money with high interest required for their craft. Other caste people also supply them raw materials of brass scraps for the craft and selling of products and also bring new orders of brass objects. Sometimes they sell their products to other caste groups, who has business of brass and bell metal objects. Earlier the caste was engaged in agriculture and that time people belonging to Gouda caste herded their cows and bullocks required for the agriculture.

Now a days there are trends of mobility found within the Kansari. Geographical mobility, individual or family mobility and group mobility through solidarity both for ritual and secular status is the current trend (Mohanti 1993).

4.10.5 Ghantara:

Ghantara are known by different names in different areas of Odisha such as Ghantar, Ghontoro, Ghantra, Ghintara and Gontra. They are one of the folk metal artisans of Odisha expertise in age-old Cire Perdue or lost wax technique of brass casting. According to Thurston (1909) they are, "A small caste of Oriya, who manufacture brass and bell metal rings and bangles for the hill people. The name is derived from Ghonto, a bellmetal plate" (Thurston 1909: 281). They are also considered as "a class of Sudras in the district of Ganjam" (Praharaj 1938) or the "name of a caste of Lohars or Blacksmiths in the Uriya country (Russel and Hira Lal 1916: 364).

The Ghataras are concentrated in the district of Gnanjam, Koraput and Mayurbhanj. They manufacture brass ornaments and utensils to fulfill the needs of ethnic groups around them. They are considered as one of the scheduled caste groups of Odisha. They claim themselves as a specialist caste like Kamara or Kharuda. Kharuda are specialized in making of different Khadu, whereas Ghantara transform scrap metals into new ornaments and utensils by lost wax process of metal casting. Their position in the social hierarchy is lower. They are considered as Harijan and also ranks lower than Saora tribe (Mohanti 1983).

Ghantara are patrilineal and their descent is traced through paternal line. They are also patrilocal. Married women live in their husband's house. They are divided into umber of *vaisa*. Each *vaisa* has different surname. *Vaisa* are exogamous and marriage within the vaisa is strictly prohibited. Marriage generally occurred in post pubescent period. They are endogamous in nature. Bridesa re mostly selected from the same village as well as from Joranda and Hindol in Dhenkanal district, Dashapala and Kantilo in Nayagarh district, Baramba in Cuttack district and also from Sambalpur district.

The kinship is based on the principle of patrilineage and is localized. In the kinship pattern indicates the distinction between consanguinal and affinal relationship. Lineal and collateral relatives are also distinguished by kinship.

There was village headman who is in-charge of law and order and the internal and external affairs of the caste. At present a female of the community is a member of the village Panchayet. Due to economic independency women can take part in the decision making of the family as well as for the village. Women also take part in different fairs and festivals arranged by the State or Central Government. They also travel abroad to exhibit their excellence of dhokra casting.

Ghanata men wear narrow cotton cloth with a towel hanging from both the shoulders round the neck. They also wear shirt and trousers. Women wear Saree without any blouse and young females wear skirts and frocks. Earlier they wear brass ornaments. Due to high price the use of brass ornaments is restricted to certain occasions.

In Sadeibereni most common festival is *Raja Parba*. There is no specific date for the festival, generally it took place five to six days after any Amavasya (New moon). They worship Goddess Durga in the jungle with flowers, fruits and also sacrifice of fowl. After that they drink country liquor and prepare for hunting in the jungle. *Gou Pujo* generally it took place in any full moon in the month of Shravan (July- August). They worship a big iron knife as symbol of the deity of power. It is performed in the jungle. They wear saffron color garments. They generally drink country liquor and prepare for ceremonial hunting in the jungle. *Karmo Pujo* is took place in the season of autumn on eighth day from the full moon "Durga Ashtami". The worship is generally performed in the jungle. They worshiped the God Shani in this festival. They generally drink liquor and celebrate the day. Deshera is took place in the season of autumn of the tenth day of full moon's. Stones as symbols of Goddess Kali and Durga are being worshiped with a big iron knife. They sacrifice goat in this festival. They also observed Poush Shankranti in winter season on the last day of the month of Poush (January). In this ceremony they worship lord Shiva and used to drink '*Bhang*', indigenous country liquor. They participate in the dance called "*Tandav Nritya*".

Nua Khai is celebrated on the tenth day of the month of Bhadra (July-August). They worship their tools and equipments in this festival and sacrifice fowl. On the last day of the Bengali month Bhadra (July-August) they worship Lord Viswakarma, the demigod. They clean their workshop and worship thie tools and equipments near the furnace. The work is restricted for the day. Beside these they worship every day at their common shrine in front of the hamlets and in every Tuesday they worship the Goddess Mangala.

4.11 Chapter summary:

Communities who are traditionally engaged in brass work are selected for the present study both in West Bengal as well as in Odisha. All of them belong to different caste groups which are endogamous in nature. In social hierarchy they belong to Sudra caste and are ranked lower than other caste groups. Gradually they achieved the higher social status due to economic upliftment in the twentieth century. The scenario is similar in West Bengal and in Odisha. From the later part of twentieth century their position became worse due to competition with other cheaper materials and also due to unavailability of raw materials. In case of lost wax metal casting the demand has been increasing and their economic condition has been improved. In Sadeibereni, Odisha they can participate in local governing body and Panchayets. The craft is parambulating in nature. According to the demand they shifted from one place to another place. Marriage distances help to know the distribution of the communities in a wide geographical range with limited overlapping.

Level of literacy of females is lower than males in general. It is also vary state wise. The literacy rate of West Bengal is higher than Odisha both in case of male and female. However female illiteracy increase in the cases of communities of Bikna in West Bengal and Sadeibereni in Odisha. Secondary education has the higher frequency in all the areas under study. This is due to their involvement in the craft in early ages as well as

due to low income. The scenario is quite different in Berhampore. There is the tendency of high education both in case of males and females.

Brass working is generally practiced by more than 50 % of total male population. Whereas in Bishnupur in West Bengal and Rathijemapatna in Odisha there is less involvement of males in the craft i.e. 16.99% and 26.45 % of total male population. Most of them shifted to other business and services. Brass working at present is generally practiced by the male folk except in Bikna of West Bengal and Sadeibereni in Odisha. Both males and females are equally engaged with the craft in those two areas. In other areas women are not allowed to participate because it is very laborious job. Women are only engaged in making of moulds and washing of finished products beside their household activities. Males are engaged in the craft from 21 to 30 years. However in Bikna and Sadebereni both males and females practice lost wax process of metal casting from their childhood. Women have full involvement with the craft and sometimes better than males in lost wax process of metal casting.

Brass working is generally practiced by traditional communities. But a number of other castes were involved in the craft both in West Bengal and Odisha. It is also to be noted that Brahmin took up brass craft as their occupation in Shibaloy in West Bengal. However the involvement of other caste in Dhokra casting in minimized both in West Bengal and in Odisha.

The ritual practices are also varies. Kamars worship Lord Viswakarma as their craft deity. However Kangsabanik of Khagra in Murshidabad district of West Bengal and Kansari of Khordha district of Odisha worship Goddess Durga as their craft deity. With adverse situation the communities are trying to sustain and also trying to maintain their caste solidarity both in West Bengal and in Odisha though there occupation mobility is present.

Table 8: Cluster-wise distribution of different communities

Sl. No.	State	Districts	Clusters	Community	No. of families	No. of individuals
1	West Bengal	Murshidabad	Berhampore	Kangsabanik	72	305
2		North Twenty Four Parganas	Shibalaya	Kangsabanik	307	1473
3		Bankura	Bishnupur	Karmakar	129	576
4		Bankura	Bikna Shilpadanga	Dokra Kamar	48	274
Sub total (Four clusters of West Bengal combined)					**556**	**2628**
5	Odisha	Khordha	Rathijemapatna	Kansari	410	2286
6		Dhenkanal	Sadeibereni	Ghantara	83	345
Sub total (Two clusters of Odisha combined)					**493**	**2631**
Total (West Bengal and Odisha)					**1049**	**5259**

Table 9.1: Frequency distribution of families on the basis of size in Berhampore, Murshidabad, West Bengal

Family size	No	%
Small (1-3 members)	26	36.11
Medium (4-6 members)	39	54.17
Large (7-9 members)	4	5.56
Very large (10+members)	3	4.17
Total	72	100.00

Figure 27.1: Frequency distribution of families on the basis of size in Berhampore, West Bengal showing in pie-chart.

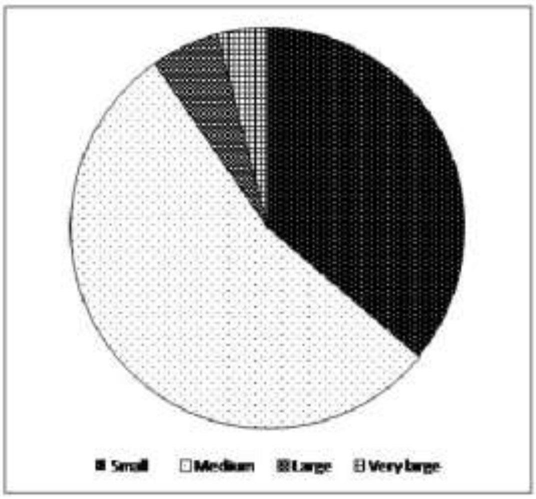


Table 9.2: Frequency distribution of families on the basis of size in Shibalaya, Dist. North 24 Pgs., West Bengal

Family size	No	%
Small (1-3 members)	99	32.25
Medium (4-6 members)	158	51.47
Large (7-9 members)	29	9.45
Very large (10+members)	21	6.84
Total	307	100.00

Figure 27.2: Frequency distribution of families on the basis of size in Shibalaya, West Bengal showing in pie-chart.

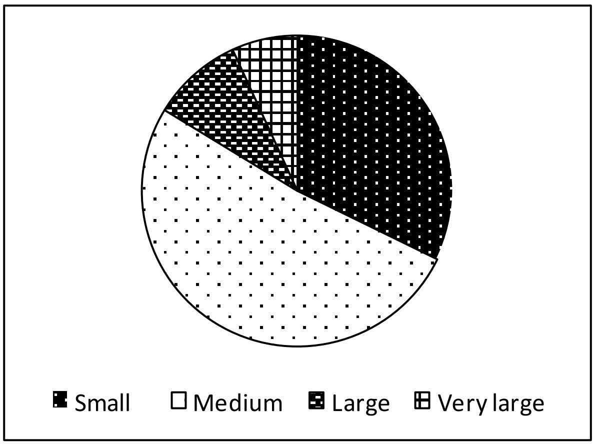


Table 9.3: Frequency distribution of families on the basis of size in Bishnupur, Bankura District, West Bengal

Family size	No	%
Small (1-3 members)	47	36.43
Medium (4-6 members)	64	49.61
Large (7-9 members)	14	10.85
Very large (10+members)	4	3.10
Total	129	100.00

Figure 27.3: Frequency distribution of families on the basis of size in Bishnupur, West Bengal showing in pie-chart.

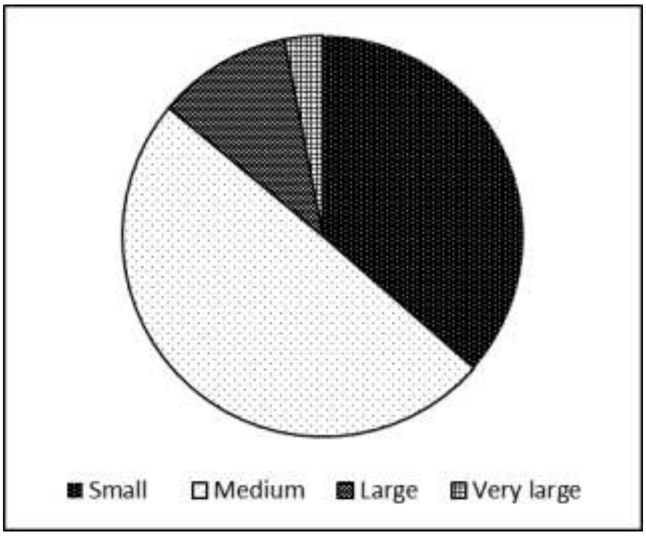


Table 9.4: Frequency distribution of families on the basis of size in Bikna, Bankura, West Bengal

Family size	No	%
Small (1-3 members)	7	14.58
Medium (4-6 members)	30	62.50
Large (7-9 members)	6	12.50
Very large (10+members)	5	10.42
Total	48	100.00

Figure 27.4: Frequency distribution of families on the basis of size in Bikna, West Bengal showing in pie-chart.

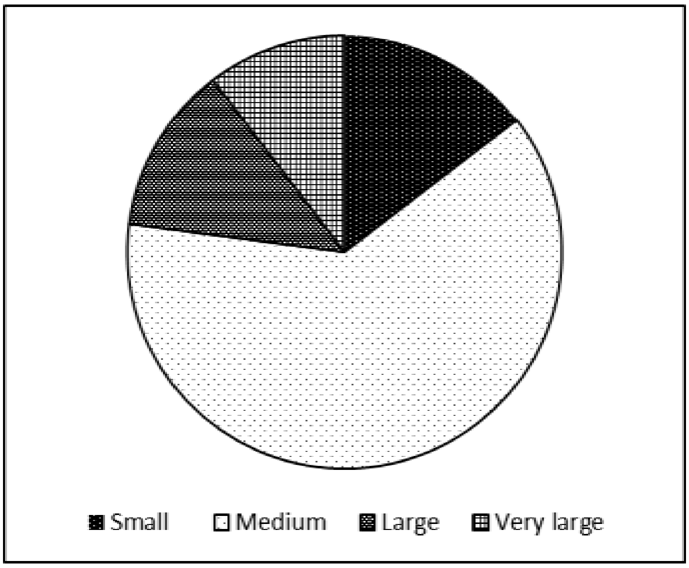


Table 9.5: Frequency distribution of families on the basis of size in Rathijemapatna, Khordha District, Odisha

Family size	No	%
Small (1-3 members)	67	16.34
Medium (4-6 members)	241	58.78
Large (7-9 members)	66	16.10
Very large (10+members)	36	8.78
Total	410	100.00

Figure 27.5: Frequency distribution of families on the basis of size in Rathijemapatna, Odisha showing in pie-chart.

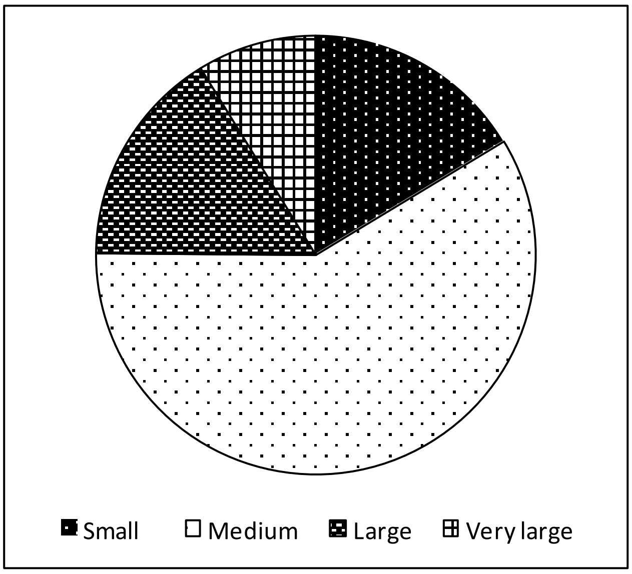


Table 9.6: Frequency distribution of families on the basis of size in Sadeibereni, Dhenkanal District, Odisha

Family size	No	%
Small (1-3 members)	29	34.94
Medium (4-6 members)	49	59.04
Large (7-9 members)	5	6.02
Total	83	100.00

Figure 27.6: Frequency distribution of families on the basis of size in Sadeibereni, Odisha showing in pie-chart.

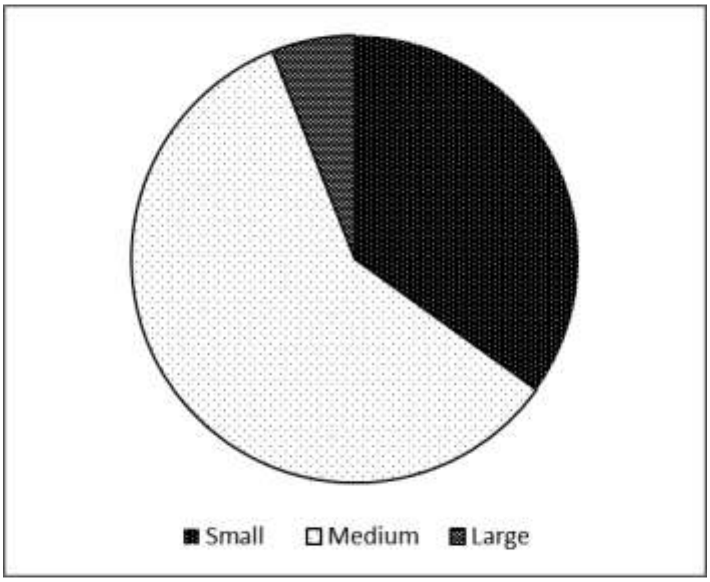


Table 10.1: Age and sex-wise distribution of the population in Berhampore, W. B.

Age groups (in Years)	Male		Female		Total	
	no.	%	no.	%	no.	%
0-10	27	8.85	16	5.25	43	14.10
11-20	25	8.20	18	5.90	43	14.10
21-30	36	11.80	46	15.08	82	26.89
31-40	28	9.18	19	6.23	47	15.41
41-50	26	8.52	18	5.90	44	14.43
51-60	15	4.92	11	3.61	26	8.52
61+	13	4.26	7	2.30	20	6.56
Total	170	55.74	135	44.26	305	100.00
Sex ratio	**794.11 female per 1000 male**					

Table10. 2: Age and sex-wise distribution of the population in Shibalaya, W.B.

Age groups (in Years)	Male		Female		Total	
	no.	%	no.	%	no.	%
0-10	102	6.92	94	6.38	196	13.31
11-20	118	8.01	123	8.35	241	16.36
21-30	179	12.15	163	11.07	342	23.22
31-40	146	9.91	115	7.81	261	17.72
41-50	117	7.94	86	5.84	203	13.78
51-60	68	4.62	45	3.05	113	7.67
61+	62	4.21	55	3.73	117	7.94
Total	792	53.77	681	46.23	1473	100.00
Sex ratio	**859.84 female per 1000 male**					

Table 10.3: Age and sex-wise distribution of the population in Bishnupur, W. B.

Age groups (in Years)	Male		Female		Total	
	no.	%	no.	%	no.	%
0-10	36	6.25	30	5.21	66	11.46
11-20	39	6.77	45	7.81	84	14.58
21-30	69	11.98	55	9.55	124	21.53
31-40	58	10.07	52	9.03	110	19.10
41-50	46	7.99	41	7.12	87	15.10
51-60	33	5.73	27	4.69	60	10.42
61+	25	4.34	20	3.47	45	7.81
Total	306	53.13	270	46.88	576	100.00
Sex ratio	**882.35 female per 1000 male**					

Table 10.4: Age and sex-wise distribution of the population in Bikna, W. B.

Age groups (in Years)	Male		Female		Total	
	no.	**%**	**no.**	**%**	**no.**	**%**
0-10	45	16.42	48	17.52	93	33.94
11-20	24	8.76	29	10.58	53	19.34
21-30	34	12.41	29	10.58	63	22.99
31-40	12	4.38	11	4.01	23	8.39
41-50	13	4.74	18	6.57	31	11.31
51-60	5	1.82	3	1.09	8	2.92
61+	0	0.00	3	1.09	3	1.09
Total	133	48.54	141	51.46	274	100.00
Sex ratio	**1060.15 female per 1000 male**					

Table 10.5: Age and sex-wise distribution of the population in Rathijema, Odisha

Age groups (in Years)	Male		Female		Total	
	no.	%	no.	%	no.	%
0-10	149	6.52	171	7.48	320	14.00
11-20	277	12.12	262	11.46	539	23.58
21-30	254	11.11	210	9.19	464	20.30
31-40	160	7.00	160	7.00	320	14.00
41-50	155	6.78	146	6.39	301	13.17
51-60	109	4.77	82	3.59	191	8.36
61+	72	3.15	79	3.46	151	6.61
Total	1176	51.44	1110	48.56	2286	100.00
Sex ratio	**943.87 female per 1000 male**					

Table 10.6: Age and sex-wise distribution of the population in Sadeibereni, Odisha

Age groups (in Years)	Male		Female		Total	
	no.	%	no.	%	no.	%
0-10	42	12.17	37	10.72	79	22.90
11-20	33	9.57	45	13.04	78	22.61
21-30	31	8.99	31	8.99	62	17.97
31-40	33	9.57	30	8.70	63	18.26
41-50	23	6.67	20	5.80	43	12.46
51-60	10	2.90	3	0.87	13	3.77
61+	4	1.16	3	0.87	7	2.03
Total	176	51.01	169	48.99	345	100.00
Sex ratio	**960.22 female per 1000 male**					

Figure 28.1: Age group-wise comparative percentages of males in different population under study

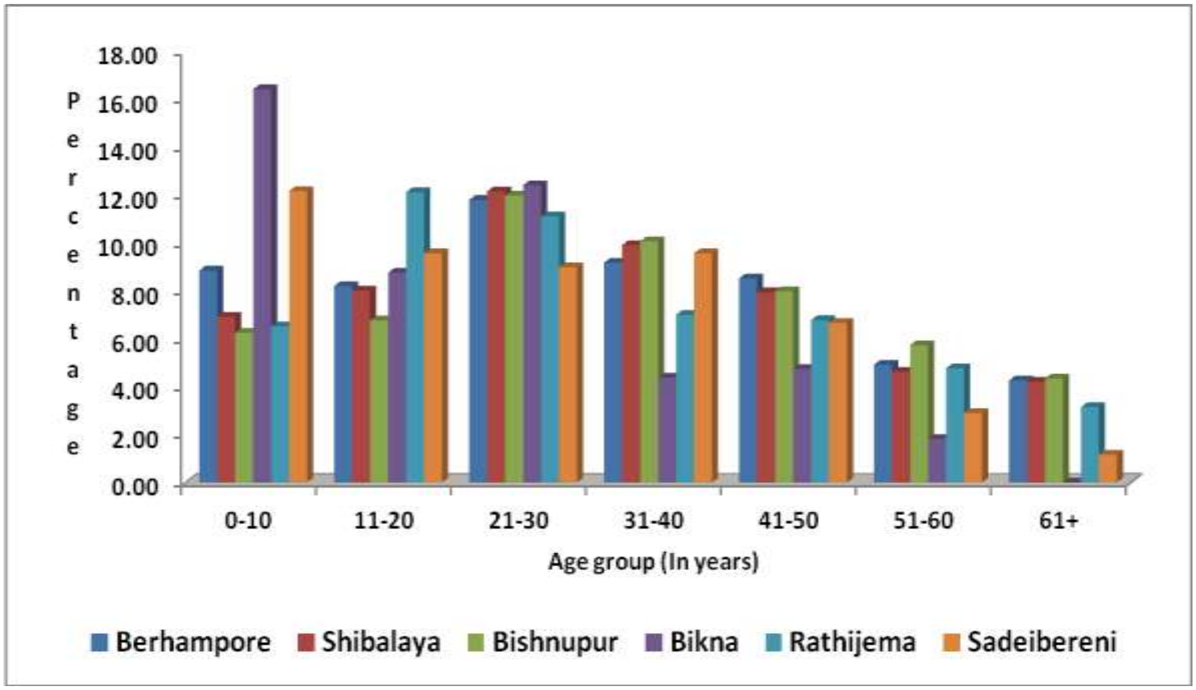


Figure 28.2: Age group-wise comparative percentages of females in different population under study

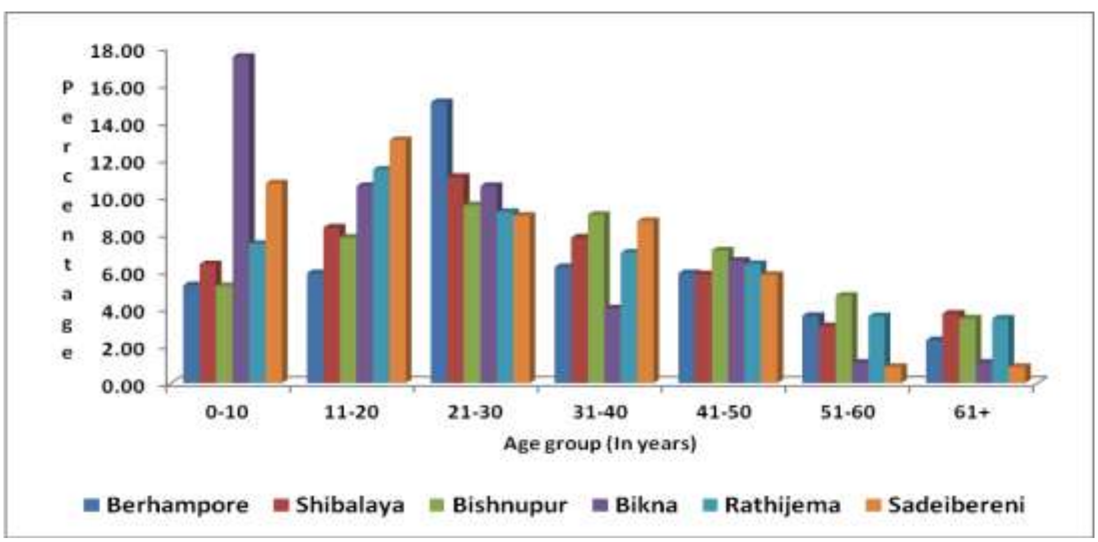
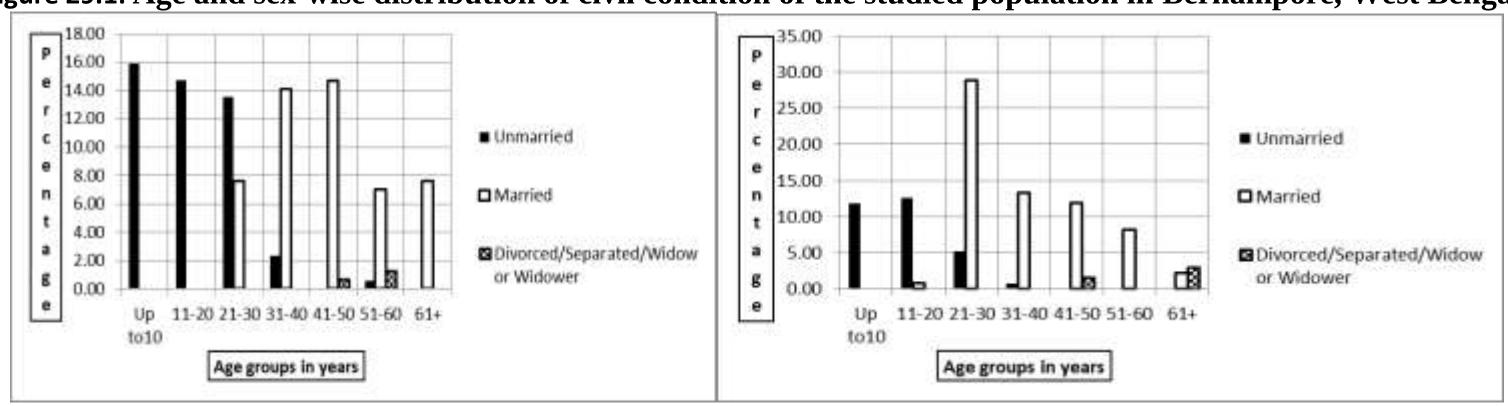


Table 11.1: Age and sex-wise distribution of civil condition of the studied population in Berhampore, West Bengal

Age group (years)	Male								Female							
	UM		M		D/S/W		Total		UM		M		D/S/W		Total	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Up to10	27	15.88	0	0.00	0	0.00	27	15.88	16	11.85	0	0.00	0	0.00	16	11.85
11-20	25	14.71	0	0.00	0	0.00	25	14.71	17	12.59	1	0.74	0	0.00	18	13.33
21-30	23	13.53	13	7.65	0	0.00	36	21.18	7	5.19	39	28.89	0	0.00	46	34.07
31-40	4	2.35	24	14.12	0	0.00	28	16.47	1	0.74	18	13.33	0	0.00	19	14.07
41-50	0	0.00	25	14.71	1	0.59	26	15.29	0	0.00	16	11.85	2	1.48	18	13.33
51-60	1	0.59	12	7.06	2	1.18	15	8.82	0	0.00	11	8.15	0	0.00	11	8.15
61+	0	0.00	13	7.65	0	0.00	13	7.65	0	0.00	3	2.22	4	2.96	7	5.19
Total	80	47.06	87	51.18	3	1.76	170	100.00	41	30.37	88	65.19	6	4.44	135	100.00

(UM = Unmarried; M = Married; D = Divorce; S = Separated; W = Widow or Widower)

Figure 29.1: Age and sex-wise distribution of civil condition of the studied population in Berhampore, West Bengal



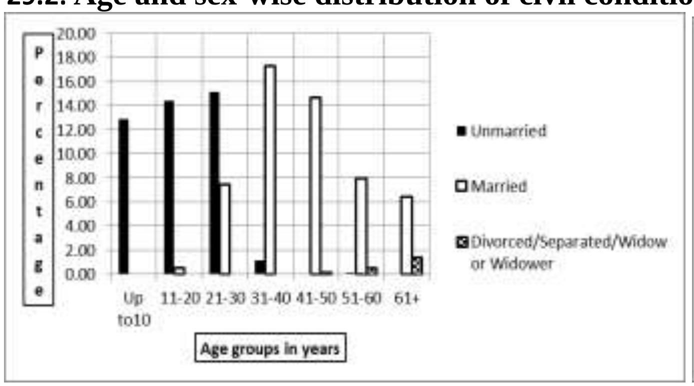
Male **Female**

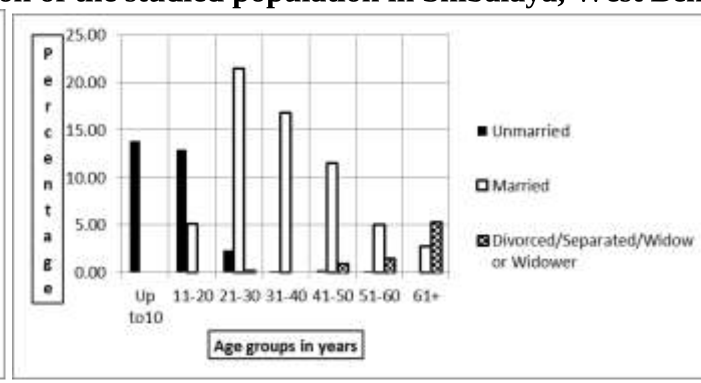
Table 11.2: Age and sex-wise distribution of civil condition of the studied population in Shibaloy, West Bengal

Age group (years)	Male								Female							
	UM		M		D/S/W		Total		UM		M		D/S/W		Total	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Up to10	102	12.88	0	0.00	0	0.00	102	12.88	94	13.80	0	0.00	0	0.00	94	13.80
11-20	114	14.39	4	0.51	0	0.00	118	14.90	88	12.92	35	5.14	0	0.00	123	18.06
21-30	120	15.15	59	7.45	0	0.00	179	22.60	16	2.35	146	21.44	1	0.15	163	23.94
31-40	9	1.14	137	17.30	0	0.00	146	18.43	1	0.15	114	16.74	0	0.00	115	16.89
41-50	0	0.00	116	14.65	1	0.13	117	14.77	2	0.29	78	11.45	6	0.88	86	12.63
51-60	1	0.13	63	7.95	4	0.51	68	8.59	1	0.15	34	4.99	10	1.47	45	6.61
61+	0	0.00	51	6.44	11	1.39	62	7.83	0	0.00	19	2.79	36	5.29	55	8.08
Total	346	43.69	430	54.29	16	2.02	792	100.00	202	29.66	426	62.56	53	7.78	681	100.00

(UM = Unmarried; M = Married; D = Divorce; S = Separated; W = Widow or Widower)

Figure 29.2: Age and sex-wise distribution of civil condition of the studied population in Shibalaya, West Bengal





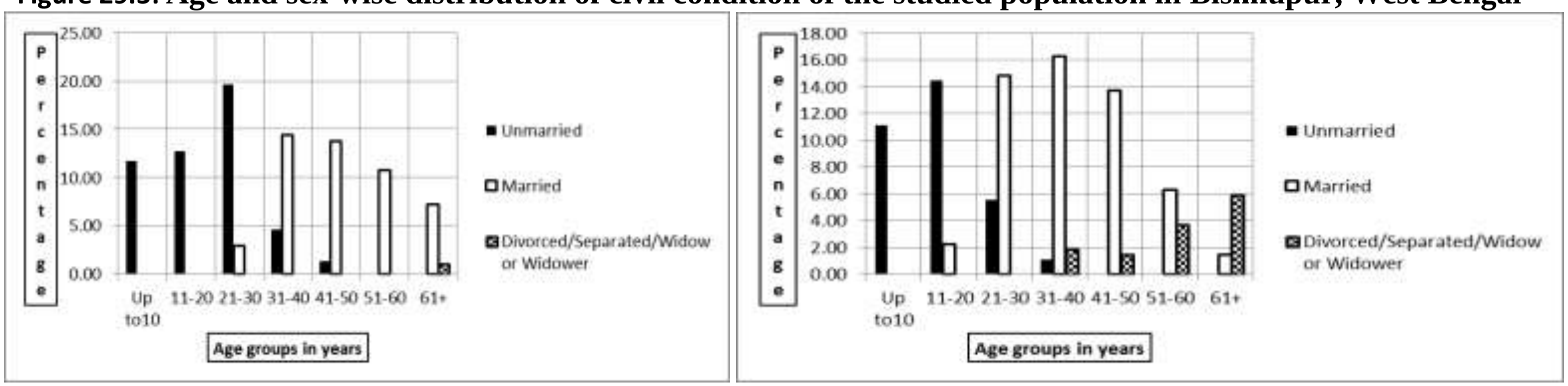
Male **Female**

Table 11.3: Age and sex-wise distribution of civil condition of the studied population in Bishnupur, West Bengal

Age group (years)	Male								Female							
	UM		M		D/S/W		Total		UM		M		D/S/W		Total	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Up to10	36	11.76	0	0.00	0	0.00	36	11.76	30	11.11	0	0.00	0	0.00	30	11.11
11-20	39	12.75	0	0.00	0	0.00	39	12.75	39	14.44	6	2.22	0	0.00	45	16.67
21-30	60	19.61	9	2.94	0	0.00	69	22.55	15	5.56	40	14.81	0	0.00	55	20.37
31-40	14	4.58	44	14.38	0	0.00	58	18.95	3	1.11	44	16.30	5	1.85	52	19.26
41-50	4	1.31	42	13.73	0	0.00	46	15.03	0	0.00	37	13.70	4	1.48	41	15.19
51-60	0	0.00	33	10.78	0	0.00	33	10.78	0	0.00	17	6.30	10	3.70	27	10.00
61+	0	0.00	22	7.19	3	0.98	25	8.17	0	0.00	4	1.48	16	5.93	20	7.41
Total	153	50.00	150	49.02	3	0.98	306	100.00	87	32.22	148	54.81	35	12.96	270	100.00

(UM = Unmarried; M = Married; D = Divorce; S = Separated; W = Widow or Widower)

Figure 29.3: Age and sex-wise distribution of civil condition of the studied population in Bishnupur, West Bengal



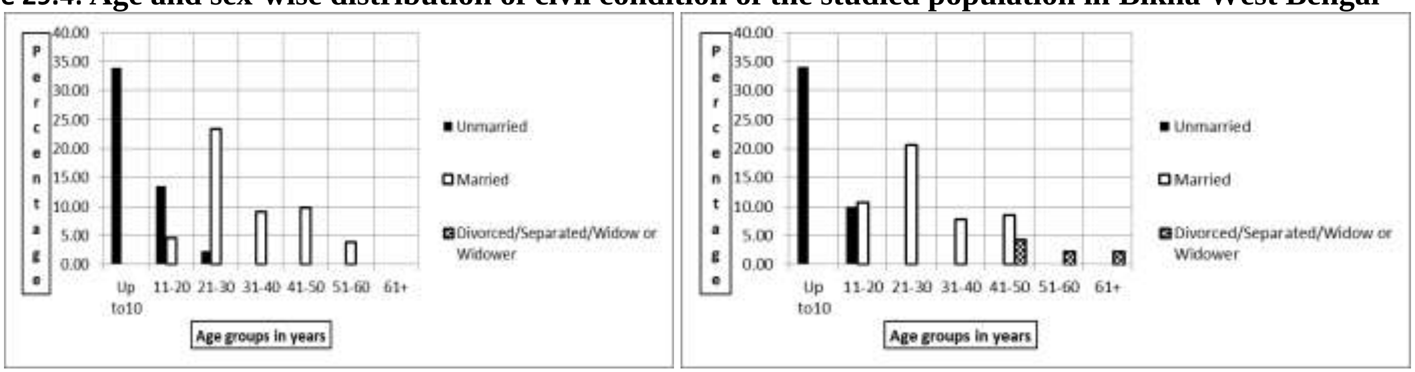
Male **Female**

Table 11.4: Age and sex-wise distribution of civil condition of the studied population in Bikna, West Bengal

Age group (years)	Male								Female							
	UM		M		D/S/W		Total		UM		M		D/S/W		Total	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Up to10	45	33.83	0	0.00	0	0.00	45	33.83	48	34.04	0	0.00	0	0.00	48	34.04
11-20	18	13.53	6	4.51	0	0.00	24	18.05	14	9.93	15	10.64	0	0.00	29	20.57
21-30	3	2.26	31	23.31	0	0.00	34	25.56	0	0.00	29	20.57	0	0.00	29	20.57
31-40	0	0.00	12	9.02	0	0.00	12	9.02	0	0.00	11	7.80	0	0.00	11	7.80
41-50	0	0.00	13	9.77	0	0.00	13	9.77	0	0.00	12	8.51	6	4.26	18	12.77
51-60	0	0.00	5	3.76	0	0.00	5	3.76	0	0.00	0	0.00	3	2.13	3	2.13
61+	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	3	2.13	3	2.13
Total	66	49.62	67	50.38	0	0.00	133	100.00	62	43.97	67	47.52	12	8.51	141	100.00

(UM = Unmarried; M = Married; D = Divorce; S = Separated; W = Widow or Widower)

Figure 29.4: Age and sex-wise distribution of civil condition of the studied population in Bikna West Bengal



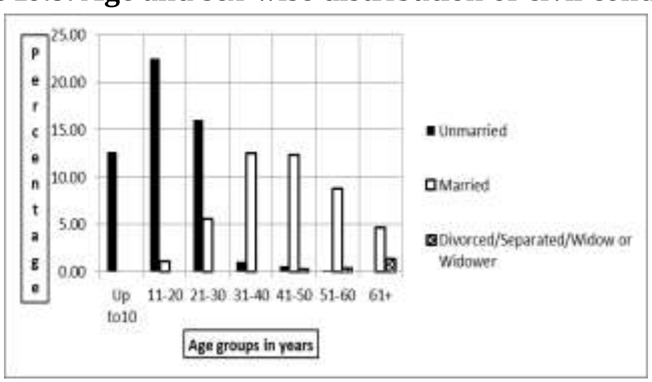
Male **Female**

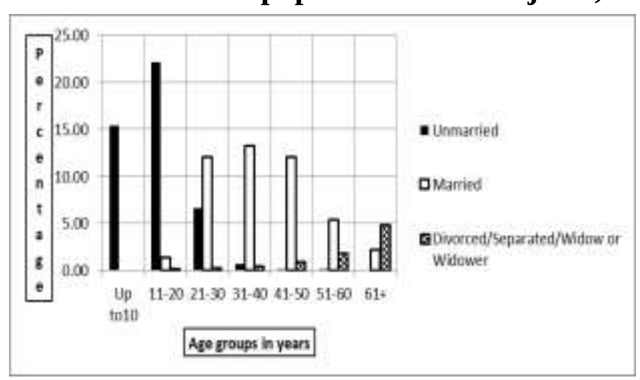
Table 11.5: Age and sex-wise distribution of civil condition of the studied population in Rathijemapatna, Odisha

Age group (years)	Male								Female							
	UM		M		D/S/W		Total		UM		M		D/S/W		Total	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Up to10	149	12.67	0	0.00	0	0.00	149	12.67	171	15.41	0	0.00	0	0.00	171	15.41
11-20	264	22.45	13	1.11	0	0.00	277	23.55	245	22.07	15	1.35	2	0.18	262	23.60
21-30	188	15.99	66	5.61	0	0.00	254	21.60	73	6.58	134	12.07	3	0.27	210	18.92
31-40	13	1.11	147	12.50	0	0.00	160	13.61	8	0.72	147	13.24	5	0.45	160	14.41
41-50	7	0.60	145	12.33	3	0.26	155	13.18	2	0.18	134	12.07	10	0.90	146	13.15
51-60	2	0.17	103	8.76	4	0.34	109	9.27	2	0.18	60	5.41	20	1.80	82	7.39
61+	1	0.09	55	4.68	16	1.36	72	6.12	1	0.09	24	2.16	54	4.86	79	7.12
Total	624	53.06	529	44.98	23	1.96	1176	100.00	502	45.23	514	46.31	94	8.47	1110	100.00

(UM = Unmarried; M = Married; D = Divorce; S = Separated; W = Widow or Widower)

Figure 29.5: Age and sex-wise distribution of civil condition of the studied population in Rathijema, Odisha





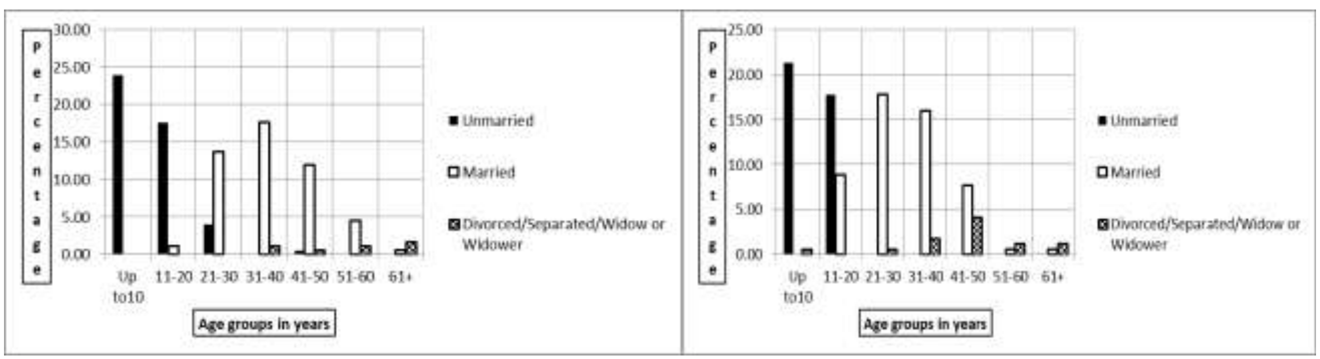
Male Female

Table 11.6: Age and sex-wise distribution of civil condition of the studied population in Sadeibereni, Odisha

Age group (years)	Male								Female							
	UM		M		D/S/W		Total		UM		M		D/S/W		Total	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Up to10	42	23.86	0	0.00	0	0.00	42	23.86	36	21.30	0	0.00	1	0.59	37	21.89
11-20	31	17.61	2	1.14	0	0.00	33	18.75	30	17.75	15	8.88	0	0.00	45	26.63
21-30	7	3.98	24	13.64	0	0.00	31	17.61	0	0.00	30	17.75	1	0.59	31	18.34
31-40	0	0.00	31	17.61	2	1.14	33	18.75	0	0.00	27	15.98	3	1.78	30	17.75
41-50	1	0.57	21	11.93	1	0.57	23	13.07	0	0.00	13	7.69	7	4.14	20	11.83
51-60	0	0.00	8	4.55	2	1.14	10	5.68	0	0.00	1	0.59	2	1.18	3	1.78
61+	0	0.00	1	0.57	3	1.70	4	2.27	0	0.00	1	0.59	2	1.18	3	1.78
Total	81	46.02	87	49.43	8	4.55	176	100.00	66	39.05	87	51.48	16	9.47	169	100.00

(UM = Unmarried; M = Married; D = Divorce; S = Separated; W = Widow or Widower)

Figure 29.6: Age and sex-wise distribution of civil condition of the studied population in Sadeibereni, Odisha

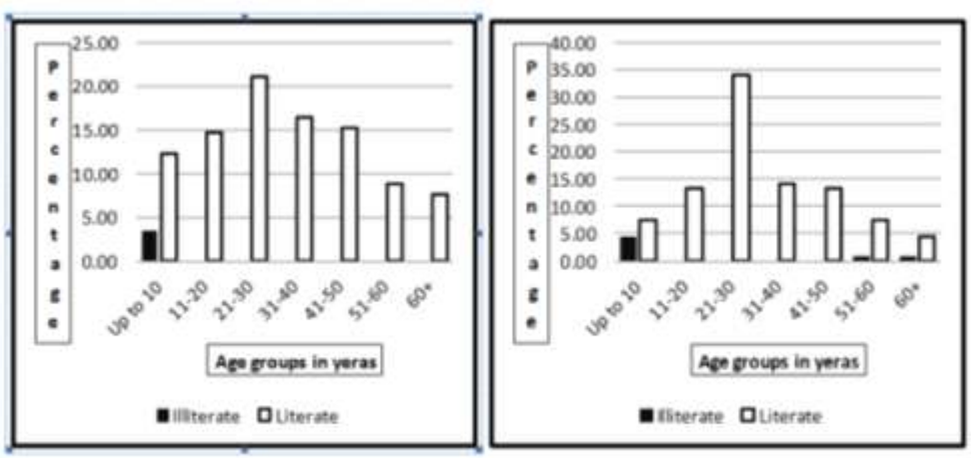


Male **Female**

Table 12.1: Age and sex-wise distribution of literacy status of population, Berhampore , W. B.

Age group (Years)	Male						Female					
	Illiterate		Literate		Total		Illiterate		Literate		Total	
	n	%	n	%	n	%	n	%	n	%	n	%
Up to 10	6	3.53	21	12.35	27	15.88	6	4.44	10	7.41	16	11.85
11-20	0	0.00	25	14.71	25	14.71	0	0.00	18	13.33	18	13.33
21-30	0	0.00	36	21.18	36	21.18	0	0.00	46	34.07	46	34.07
31-40	0	0.00	28	16.47	28	16.47	0	0.00	19	14.07	19	14.07
41-50	0	0.00	26	15.29	26	15.29	0	0.00	18	13.33	18	13.33
51-60	0	0.00	15	8.82	15	8.82	1	0.74	10	7.41	11	8.15
60+	0	0.00	13	7.65	13	7.65	1	0.74	6	4.44	7	5.19
Total	6	3.53	164	96.47	170	100.00	8	5.93	127	94.07	135	100.00

Figure 30.1: Age and sex-wise distribution of literacy status, Berhampore , W. B.

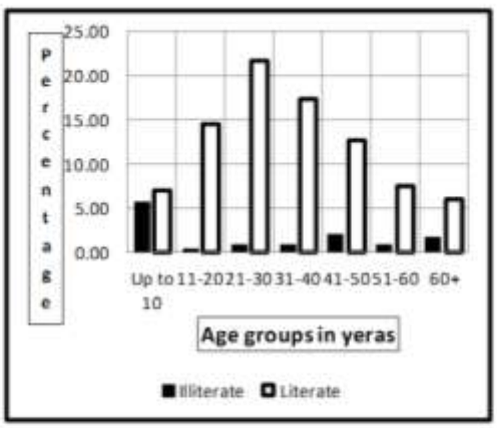


MALE FEMALE

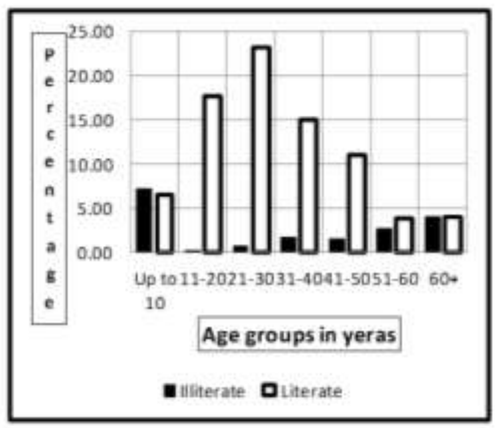
Table 12.2: Age and sex-wise distribution of literacy status of artisan, Shibalaya, W. B.

Age group (Years)	Male						Female					
	Illiterate		Literate		Total		Illiterate		Literate		Total	
	n	%	n	%	n	%	n	%	n	%	n	%
Up to 10	46	5.81	56	7.07	102	12.88	50	7.34	44	6.46	94	13.80
11-20	3	0.38	115	14.52	118	14.90	2	0.29	121	17.77	123	18.06
21-30	7	0.88	172	21.72	179	22.60	5	0.73	158	23.20	163	23.94
31-40	8	1.01	138	17.42	146	18.43	12	1.76	103	15.12	115	16.89
41-50	17	2.15	100	12.63	117	14.77	11	1.62	75	11.01	86	12.63
51-60	8	1.01	60	7.58	68	8.59	19	2.79	26	3.82	45	6.61
60+	14	1.77	48	6.06	62	7.83	28	4.11	27	3.96	55	8.08
Total	103	13.01	689	86.99	792	100.00	127	18.65	554	81.35	681	100.00

Figure 30.2: Age and sex-wise distribution of literacy status, Shibalaya, West Bengal



MALE

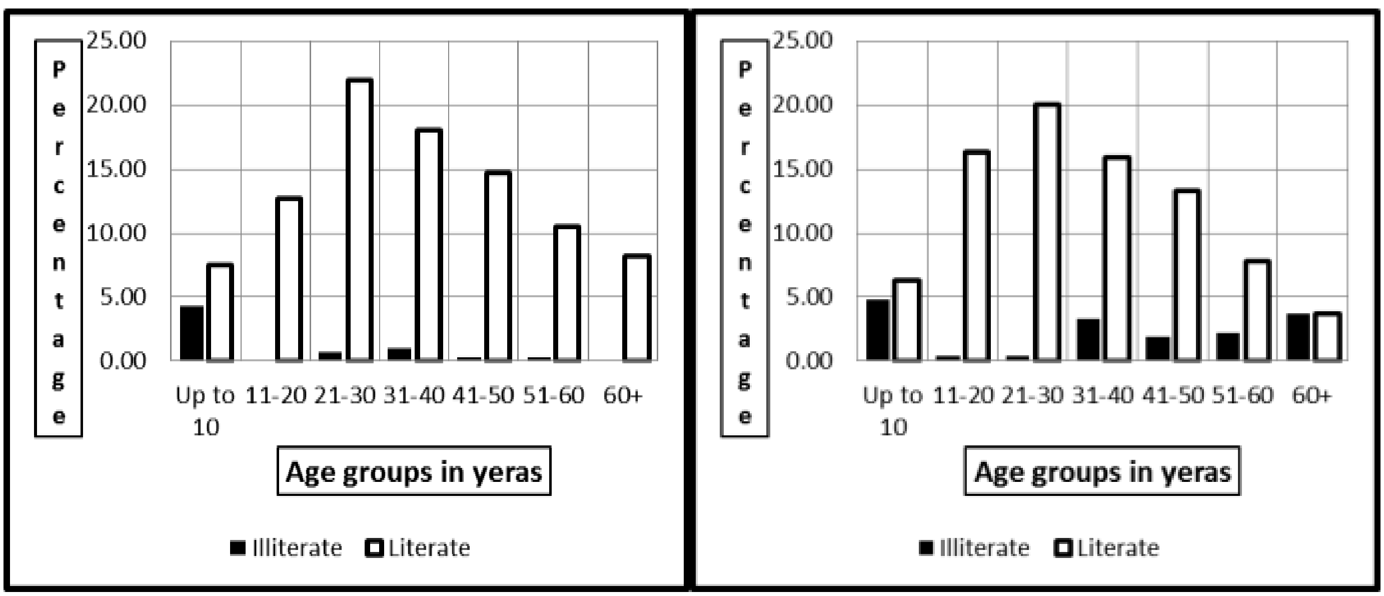


FEMALE

Table 12.3: Age and sex-wise distribution of literacy status of artisans of Bishnupur, West Bengal

Age group (Years)	Male						Female					
	Illiterate		Literate		Total		Illiterate		Literate		Total	
	n	%	n	%	n	%	n	%	n	%	n	%
Up to 10	13	4.25	23	7.52	36	11.76	13	4.81	17	6.30	30	11.11
11-20	0	0.00	39	12.75	39	12.75	1	0.37	44	16.30	45	16.67
21-30	2	0.65	67	21.90	69	22.55	1	0.37	54	20.00	55	20.37
31-40	3	0.98	55	17.97	58	18.95	9	3.33	43	15.93	52	19.26
41-50	1	0.33	45	14.71	46	15.03	5	1.85	36	13.33	41	15.19
51-60	1	0.33	32	10.46	33	10.78	6	2.22	21	7.78	27	10.00
60+	0	0.00	25	8.17	25	8.17	10	3.70	10	3.70	20	7.41
Total	20	6.54	286	93.46	306	100.00	45	16.67	225	83.33	270	100.00

Figure 30.3: Age and sex-wise distribution of literacy status, Bishnupur, West Bengal

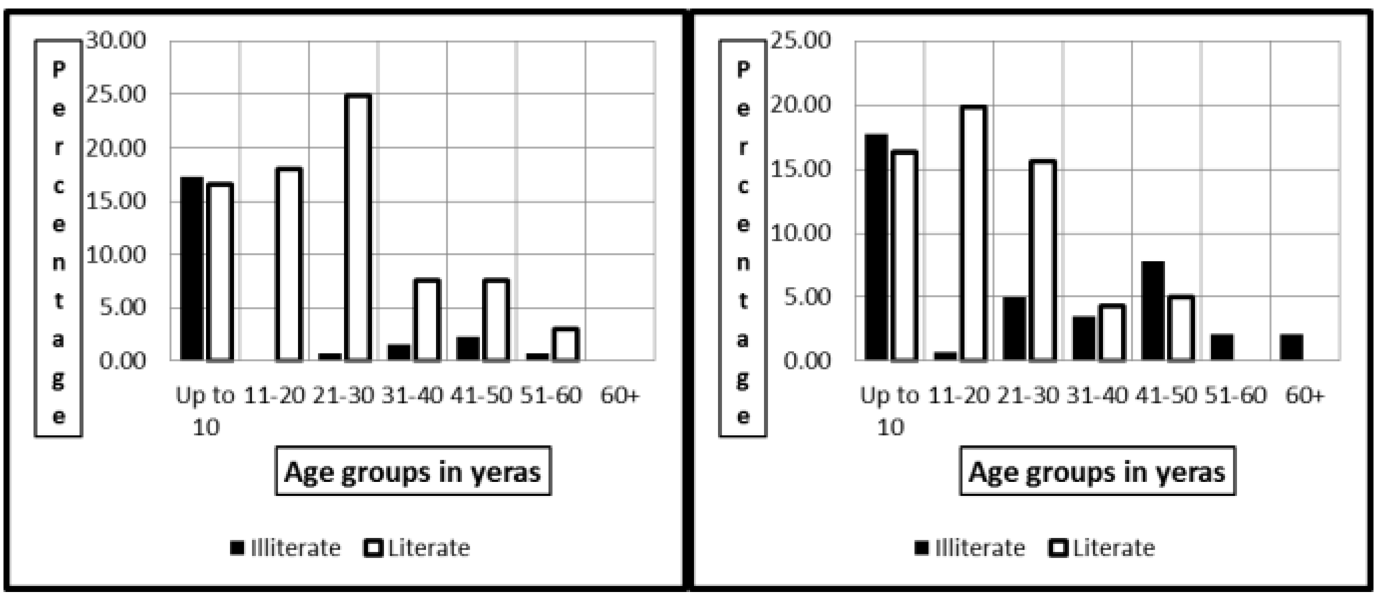


MALE **FEMALE**

Table12.4: Age and sex-wise distribution of literacy status of artisans of Bikna, W. B.

Age group (Years)	Male						Female					
	Illiterate		Literate		Total		Illiterate		Literate		Total	
	n	%	n	%	n	%	n	%	n	%	n	%
Up to 10	23	17.29	22	16.54	45	33.83	25	17.73	23	16.31	48	34.04
11-20	0	0.00	24	18.05	24	18.05	1	0.71	28	19.86	29	20.57
21-30	1	0.75	33	24.81	34	25.56	7	4.96	22	15.60	29	20.57
31-40	2	1.50	10	7.52	12	9.02	5	3.55	6	4.26	11	7.80
41-50	3	2.26	10	7.52	13	9.77	11	7.80	7	4.96	18	12.77
51-60	1	0.75	4	3.01	5	3.76	3	2.13	0	0.00	3	2.13
60+	0	0.00	0	0.00	0	0.00	3	2.13	0	0.00	3	2.13
Total	30	22.56	103	77.44	133	100.00	55	39.01	86	60.99	141	100.00

Figure 30.4: Age and sex-wise distribution of literacy status, Bikna, West Bengal

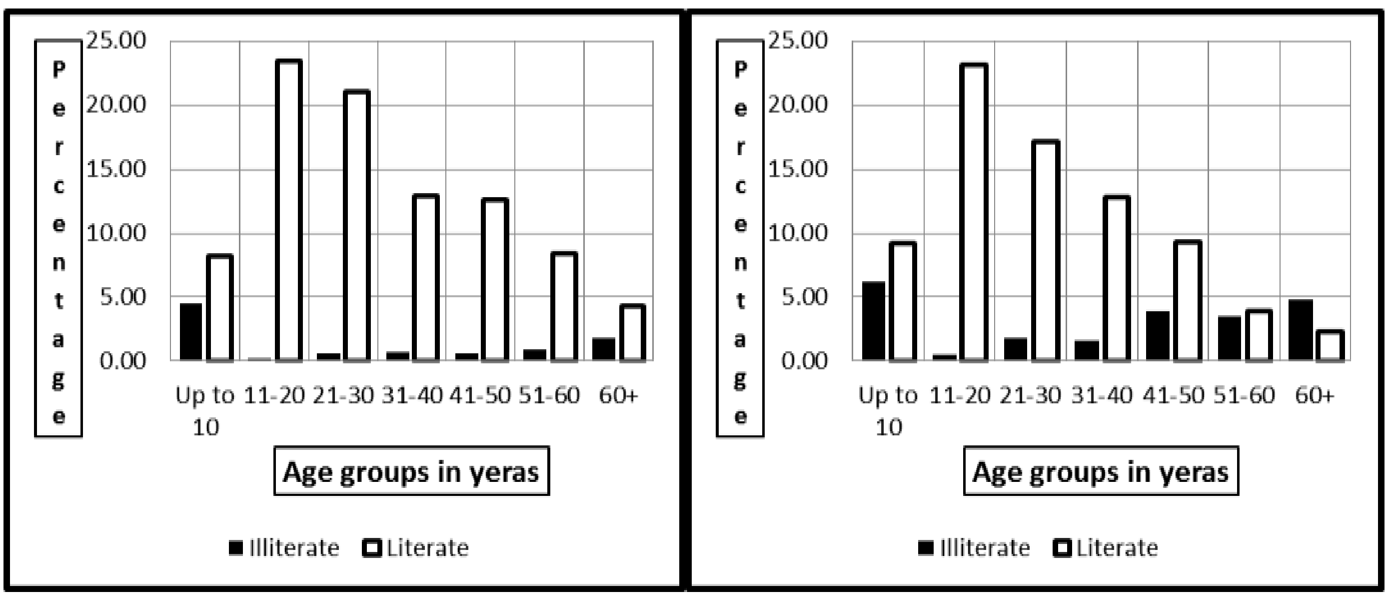


MALE **FEMALE**

Table 12.5: Age and sex-wise distribution of literacy status of artisans of Rathijemapatna, Odisha

Age group (Years)	Male						Female					
	Illiterate		Literate		Total		Illiterate		Literate		Total	
	n	%	n	%	n	%	n	%	n	%	n	%
Up to 10	53	4.51	96	8.16	149	12.67	69	6.22	102	9.19	171	15.41
11-20	2	0.17	275	23.38	277	23.55	6	0.54	256	23.06	262	23.60
21-30	7	0.60	247	21.00	254	21.60	20	1.80	190	17.12	210	18.92
31-40	8	0.68	152	12.93	160	13.61	18	1.62	142	12.79	160	14.41
41-50	7	0.60	148	12.59	155	13.18	43	3.87	103	9.28	146	13.15
51-60	10	0.85	99	8.42	109	9.27	39	3.51	43	3.87	82	7.39
60+	21	1.79	51	4.34	72	6.12	53	4.77	26	2.34	79	7.12
Total	108	9.18	1068	90.82	1176	100.00	248	22.34	862	77.66	1110	100.00

Figure 30.5: Age and sex-wise distribution of literacy status, Rathijema, Odisha

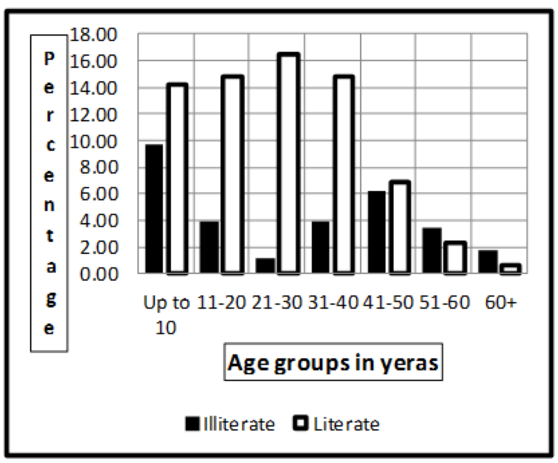


MALE **FEMALE**

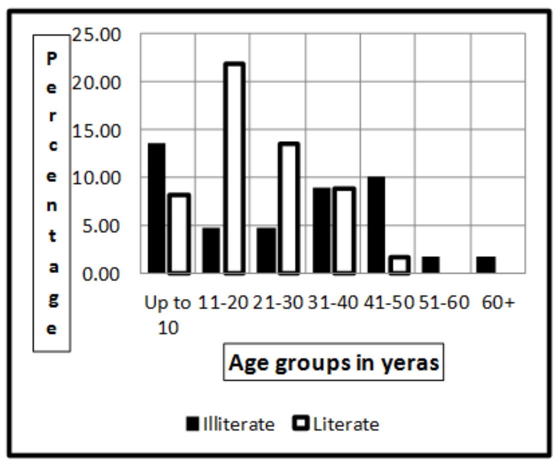
Table 12.6: Age and sex-wise distribution of literacy status of artisans of Sadeibereni, Odisha

Age group (Years)	Male						Female					
	Illiterate		Literate		Total		Illiterate		Literate		Total	
	n	%	n	%	n	%	n	%	n	%	n	%
Up to 10	17	9.66	25	14.20	42	23.86	23	13.61	14	8.28	37	21.89
11-20	7	3.98	26	14.77	33	18.75	8	4.73	37	21.89	45	26.63
21-30	2	1.14	29	16.48	31	17.61	8	4.73	23	13.61	31	18.34
31-40	7	3.98	26	14.77	33	18.75	15	8.88	15	8.88	30	17.75
41-50	11	6.25	12	6.82	23	13.07	17	10.06	3	1.78	20	11.83
51-60	6	3.41	4	2.27	10	5.68	3	1.78	0	0.00	3	1.78
60+	3	1.70	1	0.57	4	2.27	3	1.78	0	0.00	3	1.78
Total	53	30.11	123	69.89	176	100.00	77	45.56	92	54.44	169	100.00

Figure 30.6: Age and sex-wise distribution of literacy status, Sadeibereni, Odisha



MALE



FEMALE

Table 13.1 Age wise distribution of level of literacy of males in Berhampore, W. B.

Age group (in years)	Illiterate		Can sign		Primary		Secondary		H. S		Graduate+		Total	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Up to 10	6	3.53	3	1.76	16	9.41	2	1.18	0	0.00	0	0.00	27	15.88
11-20	0	0.00	0	0.00	0	0.00	21	12.35	2	1.18	2	1.18	25	14.71
21-30	0	0.00	0	0.00	0	0.00	16	9.41	12	7.06	8	4.71	36	21.18
31-40	0	0.00	1	0.59	2	1.18	20	11.76	3	1.76	2	1.18	28	16.47
41-50	0	0.00	3	1.76	4	2.35	11	6.47	3	1.76	5	2.94	26	15.29
51-60	0	0.00	4	2.35	2	1.18	6	3.53	3	1.76	0	0.00	15	8.82
61+	0	0.00	3	1.76	3	1.76	4	2.35	1	0.59	2	1.18	13	7.65
Total	6	3.53	14	8.24	27	15.88	80	47.06	24	14.11	19	11.18	170	100.00

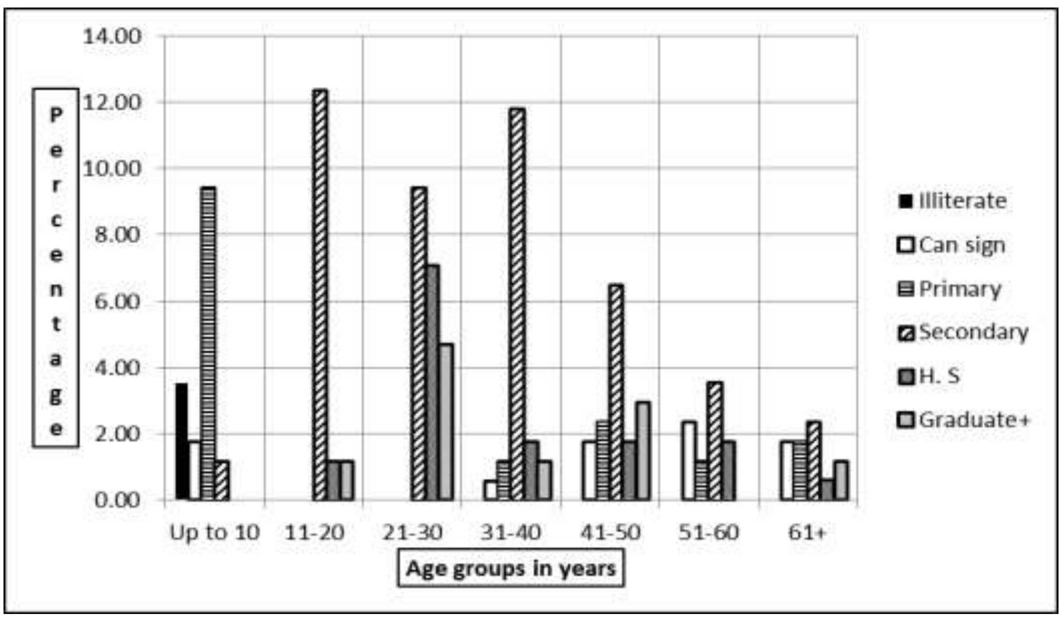


Figure 31.1: Age wise distribution of level of literacy of males in Berhampore, W. B.

Table 13.2: Age wise distribution of level of literacy of males in Shibaloy, W. B.

Age group (in years)	Illiterate		Can sign		Primary		Secondary		H. S		Graduate+		Total	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Up to 10	46	5.81	0	0.00	42	5.30	14	1.77	0	0.00	0	0.00	102	12.88
11-20	3	0.38	0	0.00	4	0.51	80	10.10	21	2.65	10	1.26	118	14.90
21-30	7	0.88	4	0.51	4	0.51	123	15.53	18	2.27	23	2.90	179	22.60
31-40	8	1.01	21	2.65	8	1.01	87	10.98	12	1.52	10	1.26	146	18.43
41-50	17	2.15	25	3.16	5	0.63	65	8.21	2	0.25	3	0.38	117	14.77
51-60	8	1.01	22	2.78	6	0.76	25	3.16	1	0.13	6	0.76	68	8.59
61+	14	1.77	25	3.16	4	0.51	14	1.77	4	0.51	1	0.13	62	7.83
Total	103	13.01	97	12.25	73	9.22	408	51.52	58	7.32	53	6.69	792	100.00

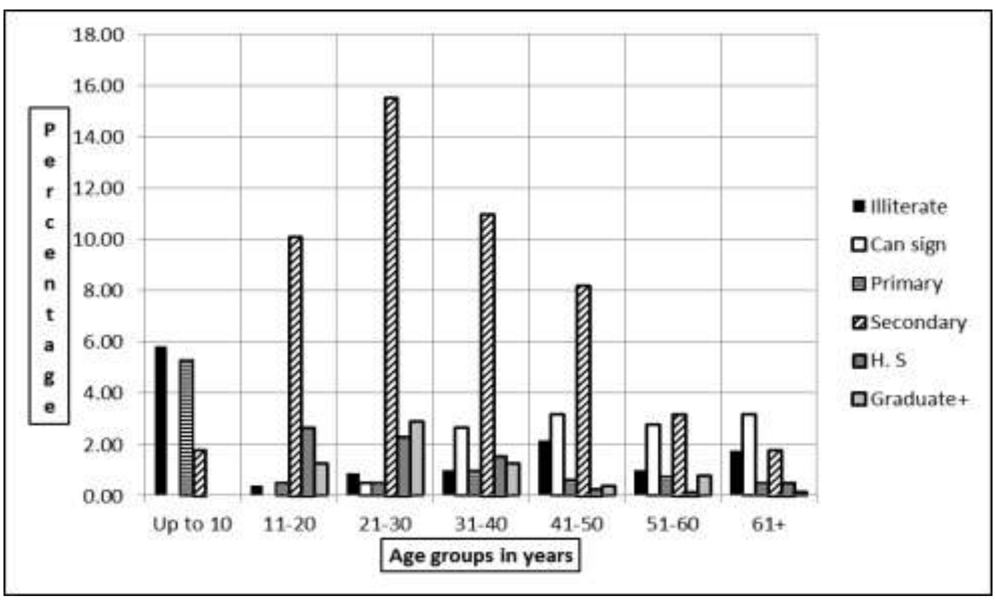


Figure 31.2: Age wise distribution of level of literacy of males in Shibalaya, W. B.

Table 13.3: Age wise distribution of level of literacy of males in Bishnupur, W. B.

Age group (in years)	Illiterate		Can sign		Primary		Secondary		H. S		Graduate+		Total	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Up to 10	13	4.25	0	0.00	21	6.86	2	0.65	0	0.00	0	0.00	36	11.76
11-20	0	0.00	0	0.00	3	0.98	27	8.82	7	2.29	2	0.65	39	12.75
21-30	2	0.65	1	0.33	1	0.33	37	12.09	11	3.59	17	5.56	69	22.55
31-40	3	0.98	6	1.96	6	1.96	26	8.50	4	1.31	13	4.25	58	18.95
41-50	1	0.33	5	1.63	10	3.27	17	5.56	3	0.98	10	3.27	46	15.03
51-60	1	0.33	3	0.98	9	2.94	9	2.94	2	0.65	9	2.94	33	10.78
61+	0	0.00	3	0.98	9	2.94	11	3.59	1	0.33	1	0.33	25	8.17
Total	20	6.54	18	5.88	59	19.28	129	42.16	28	9.15	52	16.99	306	100.00

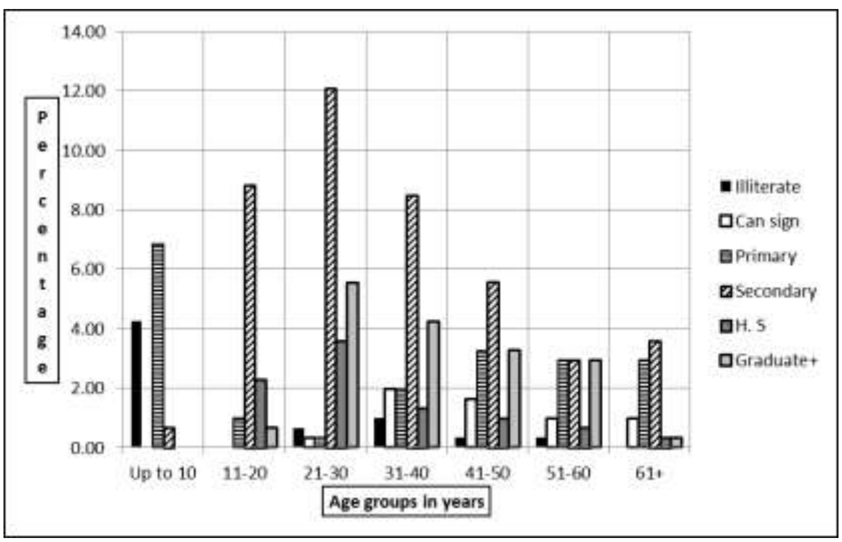


Figure 31.3: Age wise distribution of level of literacy of males in Bishnupur, W. B.

Table13.4: Age wise distribution of level of literacy of males in Bikna, W. B.

Age group (in years)	Illiterate		Can sign		Primary		Secondary		H. S		Graduate+		Total	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Up to 10	23	17.29	1	0.75	21	15.79	0	0.00	0	0.00	0	0.00	45	33.83
11-20	0	0.00	3	2.26	12	9.02	9	6.77	0	0.00	0	0.00	24	18.05
21-30	1	0.75	6	4.51	16	12.03	11	8.27	0	0.00	0	0.00	34	25.56
31-40	2	1.50	3	2.26	2	1.50	5	3.76	0	0.00	0	0.00	12	9.02
41-50	3	2.26	5	3.76	3	2.26	2	1.50	0	0.00	0	0.00	13	9.77
51-60	1	0.75	1	0.75	2	1.50	1	0.75	0	0.00	0	0.00	5	3.76
Total	30	22.56	19	14.29	56	42.10	28	21.05	0	0.00	0	0.00	133	100.00

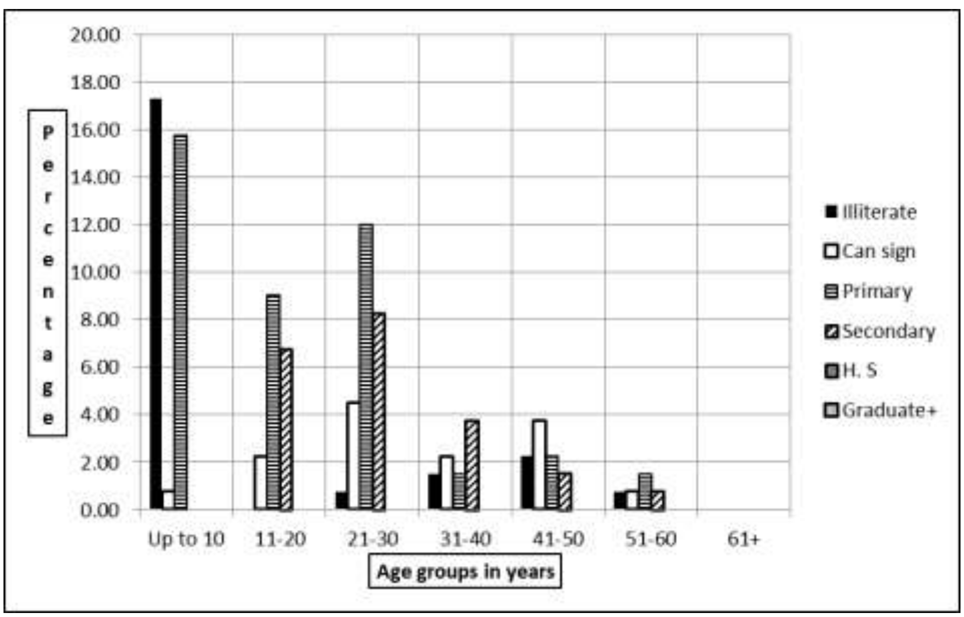


Figure 31.4: Age wise distribution of level of literacy of males in Bikna, W. B.

Table 13.5: Age wise distribution of level of literacy of males in Rathijemapatna, Odisha

Age group (in years)	Illiterate		Can sign		Primary		Secondary		H. S		Graduate+		Total	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Up to 10	53	4.51	10	0.85	68	5.78	18	1.53	0	0.00	0	0.00	149	12.67
11-20	2	0.17	2	0.17	17	1.45	209	17.77	37	3.15	10	0.85	277	23.55
21-30	7	0.60	5	0.43	18	1.53	160	13.61	27	2.30	37	3.15	254	21.60
31-40	8	0.68	8	0.68	28	2.38	89	7.57	7	0.60	20	1.70	160	13.61
41-50	7	0.60	11	0.94	28	2.38	102	8.67	2	0.17	5	0.43	155	13.18
51-60	10	0.85	18	1.53	27	2.30	48	4.08	1	0.09	5	0.43	109	9.27
61+	21	1.79	27	2.30	16	1.36	7	0.60	1	0.09	0	0.00	72	6.12
Total	108	9.18	81	6.89	202	17.18	633	53.83	75	6.38	77	6.55	1176	100.00

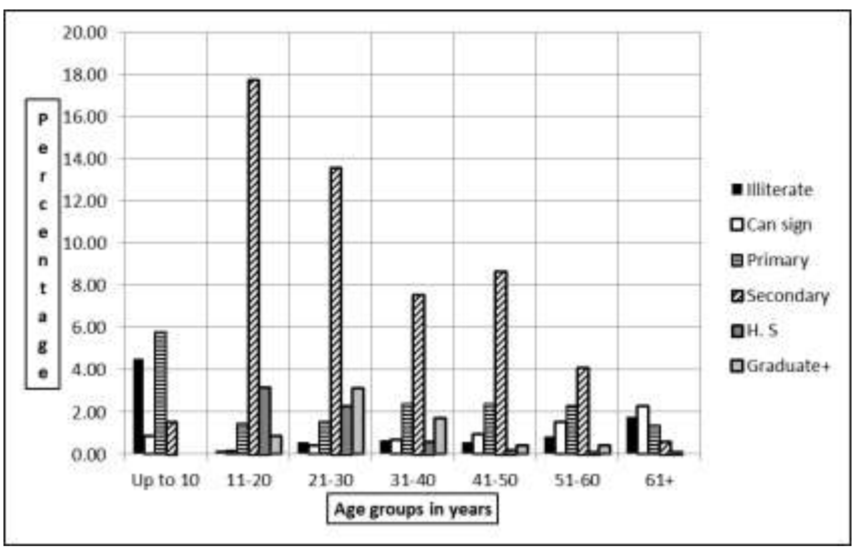


Figure 31.5: Age wise distribution of level of literacy of males in Rathijema, Odisha

Table 13.6: Age wise distribution of level of literacy of males in Sadeibereni, Odisha

Age group (in years)	Illiterate		Can sign		Primary		Secondary		H. S		Graduate+		Total	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Up to 10	17	9.66	0	0.00	20	11.36	5	2.84	0	0.00	0	0.00	42	23.86
11-20	7	3.98	3	1.70	5	2.84	17	9.66	1	0.57	0	0.00	33	18.75
21-30	2	1.14	8	4.55	10	5.68	11	6.25	0	0.00	0	0.00	31	17.61
31-40	7	3.98	9	5.11	2	1.14	15	8.52	0	0.00	0	0.00	33	18.75
41-50	11	6.25	5	2.84	2	1.14	5	2.84	0	0.00	0	0.00	23	13.07
51-60	6	3.41	4	2.27	0	0.00	0	0.00	0	0.00	0	0.00	10	5.68
61+	3	1.70	0	0.00	0	0.00	1	0.57	0	0.00	0	0.00	4	2.27
Total	53	30.11	29	16.48	39	22.16	54	30.68	1	0.57	0	0.00	176	100.00

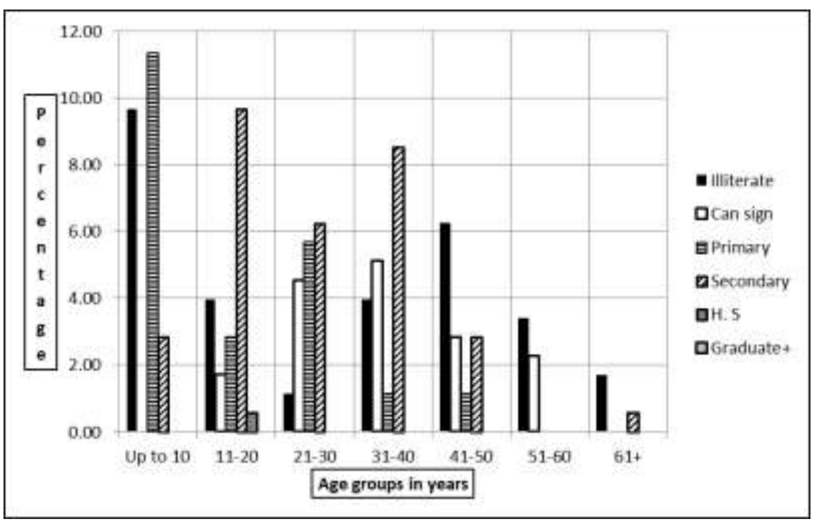


Figure 31.6: Age wise distribution of level of literacy of males in Sadeibereni, Odisha

Table 14.1: Age wise distribution of level of literacy of females in Berhampore, West Bengal

Age group (in years)	Illiterate		Can sign		Primary		Secondary		H. S		Graduate+		Total	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Up to 10	6	4.44	2	1.48	8	5.93	0	0.00	0	0.00	0	0.00	16	11.85
11-20	0	0.00	0	0.00	1	0.74	7	5.19	9	6.67	1	0.74	18	13.33
21-30	0	0.00	0	0.00	3	2.22	29	21.48	5	3.70	9	6.67	46	34.07
31-40	0	0.00	2	1.48	2	1.48	9	6.67	2	1.48	4	2.96	19	14.07
41-50	0	0.00	5	3.70	3	2.22	7	5.19	3	2.22	0	0.00	18	13.33
51-60	1	0.74	2	1.48	3	2.22	4	2.96	1	0.74	0	0.00	11	8.15
61+	1	0.74	1	0.74	1	0.74	3	2.22	1	0.74	0	0.00	7	5.19
Total	8	5.93	12	8.89	21	15.56	59	43.70	21	15.56	14	10.37	135	100.00

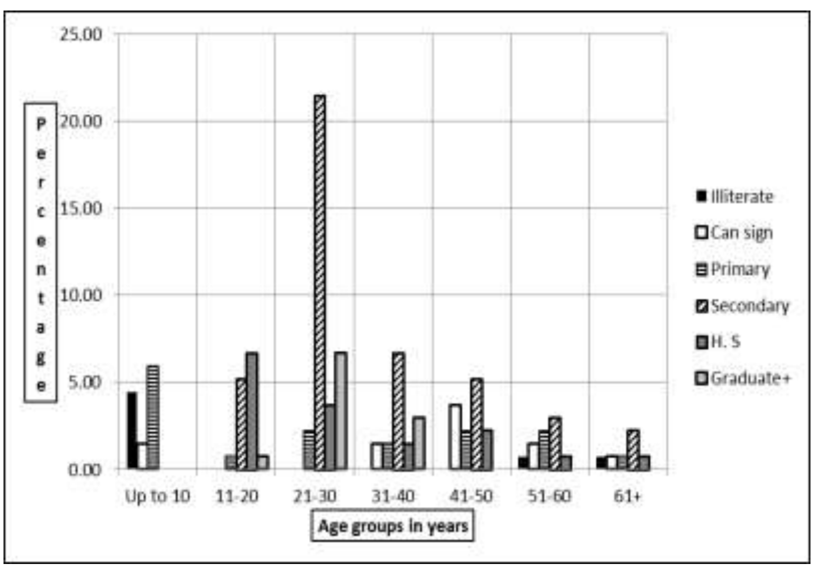


Figure 31.7: Age wise distribution of level of literacy of females in Berhampore, West Bengal

Table 14.2 Age wise distribution of level of literacy of females in Shibalaya, West Bengal

Age group (in years)	Illiterate		Can sign		Primary		Secondary		H. S		Graduate+		Total	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Up to 10	50	7.34	0	0.00	36	5.29	8	1.17	0	0.00	0	0.00	94	13.80
11-20	2	0.29	0	0.00	0	0.00	89	13.07	25	3.67	7	1.03	123	18.06
21-30	5	0.73	6	0.88	5	0.73	113	16.59	19	2.79	15	2.20	163	23.94
31-40	12	1.76	14	2.06	7	1.03	79	11.60	1	0.15	2	0.29	115	16.89
41-50	11	1.62	22	3.23	3	0.44	48	7.05	1	0.15	1	0.15	86	12.63
51-60	19	2.79	12	1.76	3	0.44	11	1.62	0	0.00	0	0.00	45	6.61
61+	28	4.11	16	2.35	3	0.44	8	1.17	0	0.00	0	0.00	55	8.08
Total	127	18.65	70	10.28	57	8.37	356	52.28	46	6.75	25	3.67	681	100.00

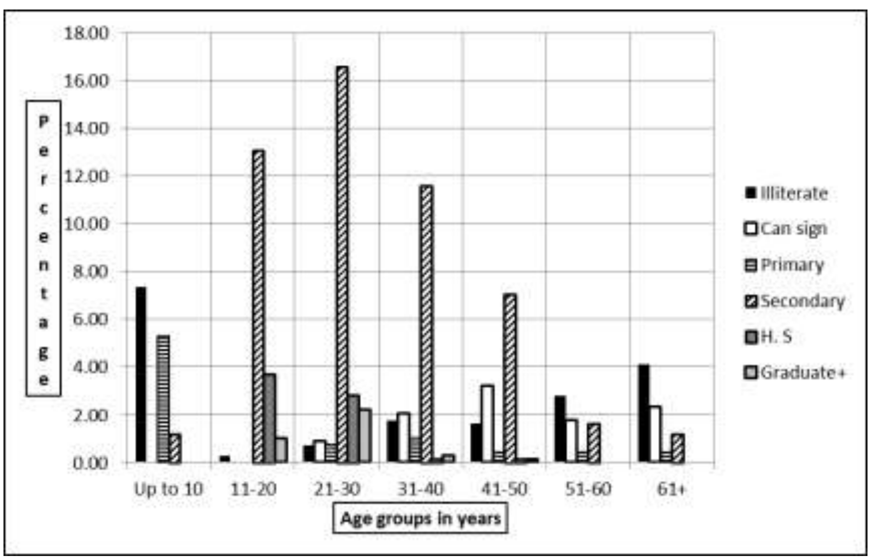


Figure 31.8: Age wise distribution of level of literacy of females in Shibalaya, West Bengal

Table 14.3: Age wise distribution of level of literacy of females in Bishnupur, West Bengal

Age group (in years)	Illiterate		Can sign		Primary		Secondary		H. S		Graduate+		Total	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Up to 10	13	4.81	0	0.00	15	5.56	2	0.74	0	0.00	0	0.00	30	11.11
11-20	1	0.37	0	0.00	2	0.74	30	11.11	8	2.96	4	1.48	45	16.67
21-30	1	0.37	4	1.48	3	1.11	35	12.96	6	2.22	6	2.22	55	20.37
31-40	9	3.33	5	1.85	5	1.85	27	10.00	4	1.48	2	0.74	52	19.26
41-50	5	1.85	4	1.48	12	4.44	18	6.67	1	0.37	1	0.37	41	15.19
51-60	6	2.22	6	2.22	8	2.96	5	1.85	1	0.37	1	0.37	27	10.00
61+	10	3.70	4	1.48	6	2.22	0	0.00	0	0.00	0	0.00	20	7.41
Total	45	16.67	23	8.52	51	18.89	117	43.33	20	7.41	14	5.18	270	100.00

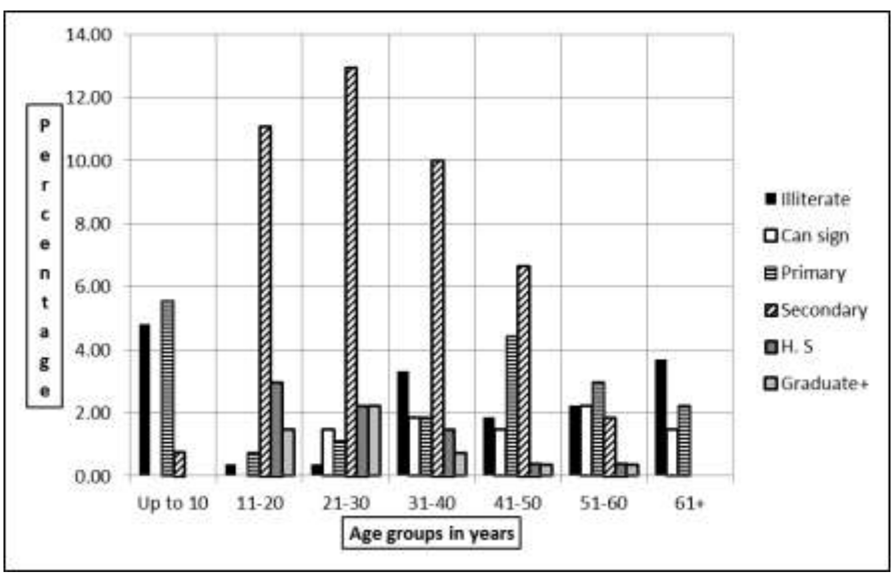


Figure 31.9: Age wise distribution of level of literacy of females in Bishnupur, West Bengal

Table 14.4: Age wise distribution of level of literacy of females in Bikna, West Bengal

Age group (in years)	Illiterate		Can sign		Primary		Secondary		H. S		Graduate+		Total	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Up to 10	25	17.73	3	2.13	20	14.18	0	0.00	0	0.00	0	0.00	48	34.04
11-20	1	0.71	5	3.55	12	8.51	11	7.80	0	0.00	0	0.00	29	20.57
21-30	7	4.96	11	7.80	7	4.96	4	2.84	0	0.00	0	0.00	29	20.57
31-40	5	3.55	4	2.84	1	0.71	1	0.71	0	0.00	0	0.00	11	7.80
41-50	11	7.80	5	3.55	0	0.00	2	1.42	0	0.00	0	0.00	18	12.77
51-60	3	2.13	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	3	2.13
61+	3	2.13	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	3	2.13
Total	55	39.01	28	19.86	40	28.36	18	12.77	0	0.00	0	0.00	141	100.00

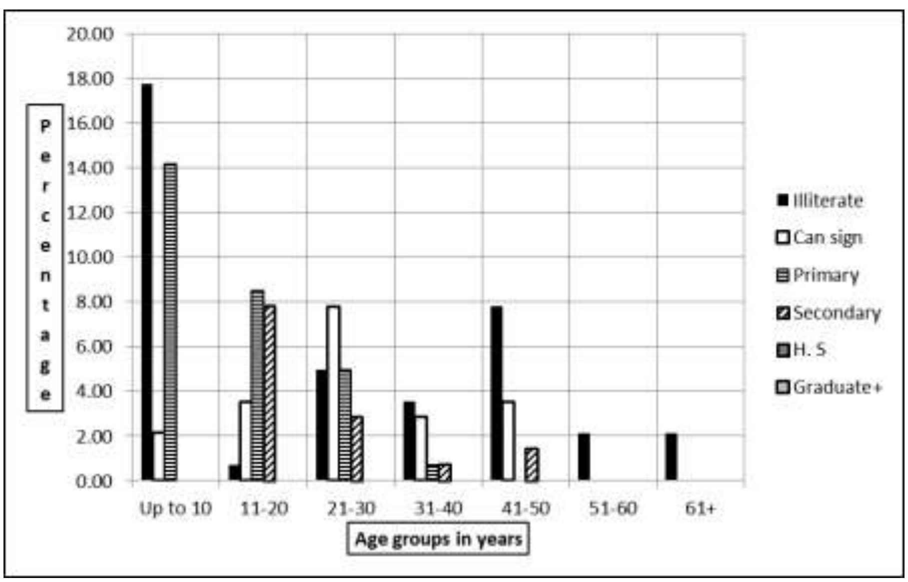


Figure 31.10: Age wise distribution of level of literacy of females in Bikna, West Bengal

Table 14.5: Age wise distribution of level of literacy of females in Rathijemapatna, Odisha

Age group (in years)	Illiterate		Can sign		Primary		Secondary		H. S		Graduate+		Total	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Up to 10	69	6.22	14	1.26	69	6.22	19	1.71	0	0.00	0	0.00	171	15.41
11-20	6	0.54	5	0.45	11	0.99	212	19.10	21	1.89	7	0.63	262	23.60
21-30	20	1.80	29	2.61	25	2.25	103	9.28	15	1.35	18	1.62	210	18.92
31-40	18	1.62	29	2.61	35	3.15	71	6.40	4	0.36	3	0.27	160	14.41
41-50	43	3.87	41	3.69	25	2.25	35	3.15	2	0.18	0	0.00	146	13.15
51-60	39	3.51	15	1.35	16	1.44	12	1.08	0	0.00	0	0.00	82	7.39
61+	53	4.77	21	1.89	4	0.36	1	0.09	0	0.00	0	0.00	79	7.12
Total	248	22.34	154	13.87	185	16.67	453	40.81	42	3.78	28	2.52	1110	100.00

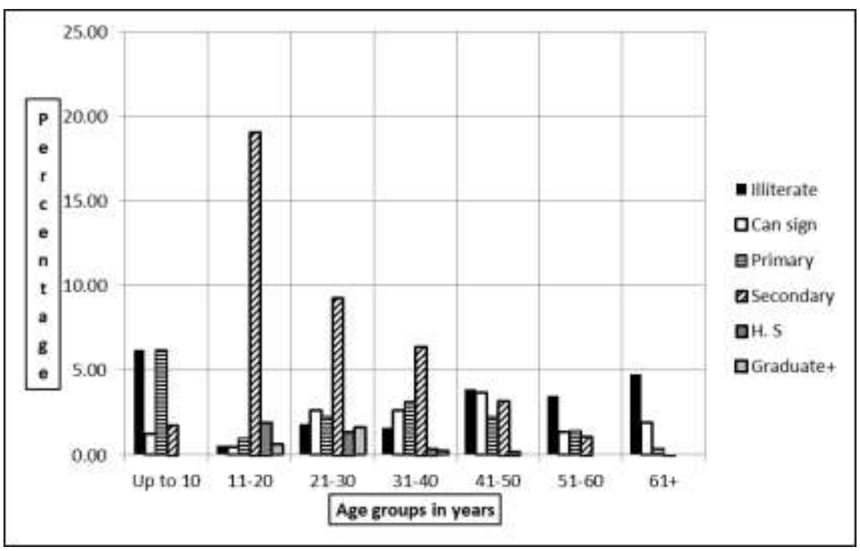


Figure 31.11: Age wise distribution of level of literacy of females in Rathijemapatna, Odisha

Table 14.6: Age wise distribution of level of literacy of females in Sadeibereni, Odisha

Age group (in years)	Illiterate		Can sign		Primary		Secondary		H. S		Graduate+		Total	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Up to 10	23	13.61	1	0.59	10	5.92	3	1.78	0	0.00	0	0.00	37	21.89
11-20	8	4.73	8	4.73	13	7.69	16	9.47	0	0.00	0	0.00	45	26.63
21-30	8	4.73	8	4.73	5	2.96	10	5.92	0	0.00	0	0.00	31	18.34
31-40	15	8.88	12	7.10	2	1.18	1	0.59	0	0.00	0	0.00	30	17.75
41-50	17	10.06	1	0.59	2	1.18	0	0.00	0	0.00	0	0.00	20	11.83
51-60	3	1.78	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	3	1.78
61+	3	1.78	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	3	1.78
Total	77	45.56	30	17.75	32	18.93	30	17.76	0	0.00	0	0.00	169	100.00

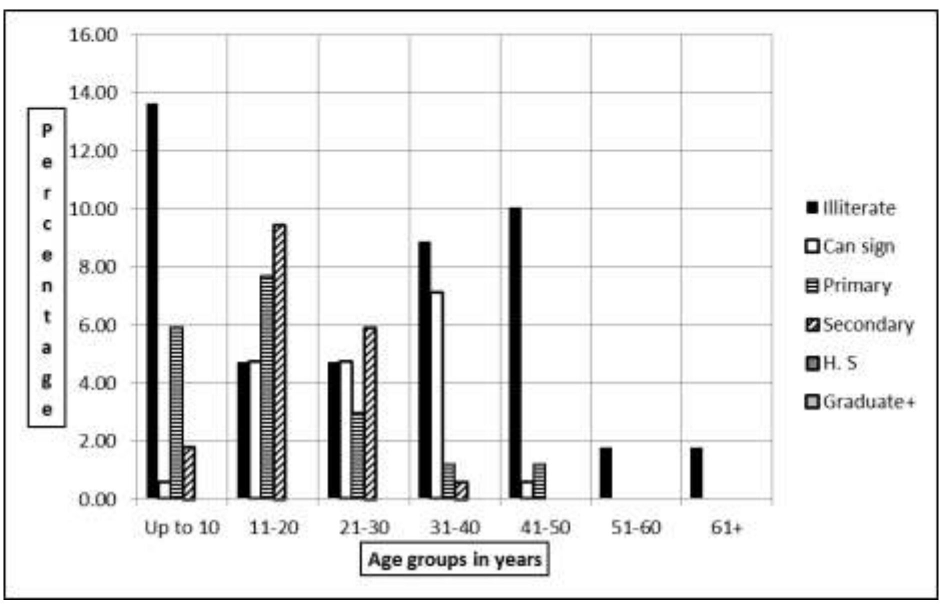


Figure 31.12: Age wise distribution of level of literacy of females in Sadeibereni, Odisha

Table 15.1: Frequency distribution of occupational pattern in relation to age group of males in Berhampore, W. B.

Age groups in years	Metal work		Occupations other than metal work												Total	
			Agriculture		Service		Business		Daily wage labour		Student		Unemployed			
	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%
Up to 10	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	15	8.82	12	7.06	27	15.88
11-20	7	4.12	0	0.00	0	0.00	0	0.00	1	0.59	17	10.00	0	0.00	25	14.71
21-30	20	11.76	1	0.59	3	1.76	8	4.71	0	0.00	1	0.59	3	1.76	36	21.18
31-40	22	12.94	0	0.00	1	0.59	3	1.76	2	1.18	0	0.00	0	0.00	28	16.47
41-50	16	9.41	1	0.59	3	1.76	6	3.53	0	0.00	0	0.00	0	0.00	26	15.29
51-60	11	6.47	0	0.00	0	0.00	3	1.76	0	0.00	0	0.00	1	0.59	15	8.82
61+	8	4.71	0	0.00	2	1.18	0	0.00	0	0.00	0	0.00	3	1.76	13	7.65
Total	84	49.41	2	1.18	9	5.29	20	11.76	3	1.76	33	19.41	19	11.18	170	100.00

Figure 32.1: Occupational pattern in relation to age group of males, Berhampore, West Bengal

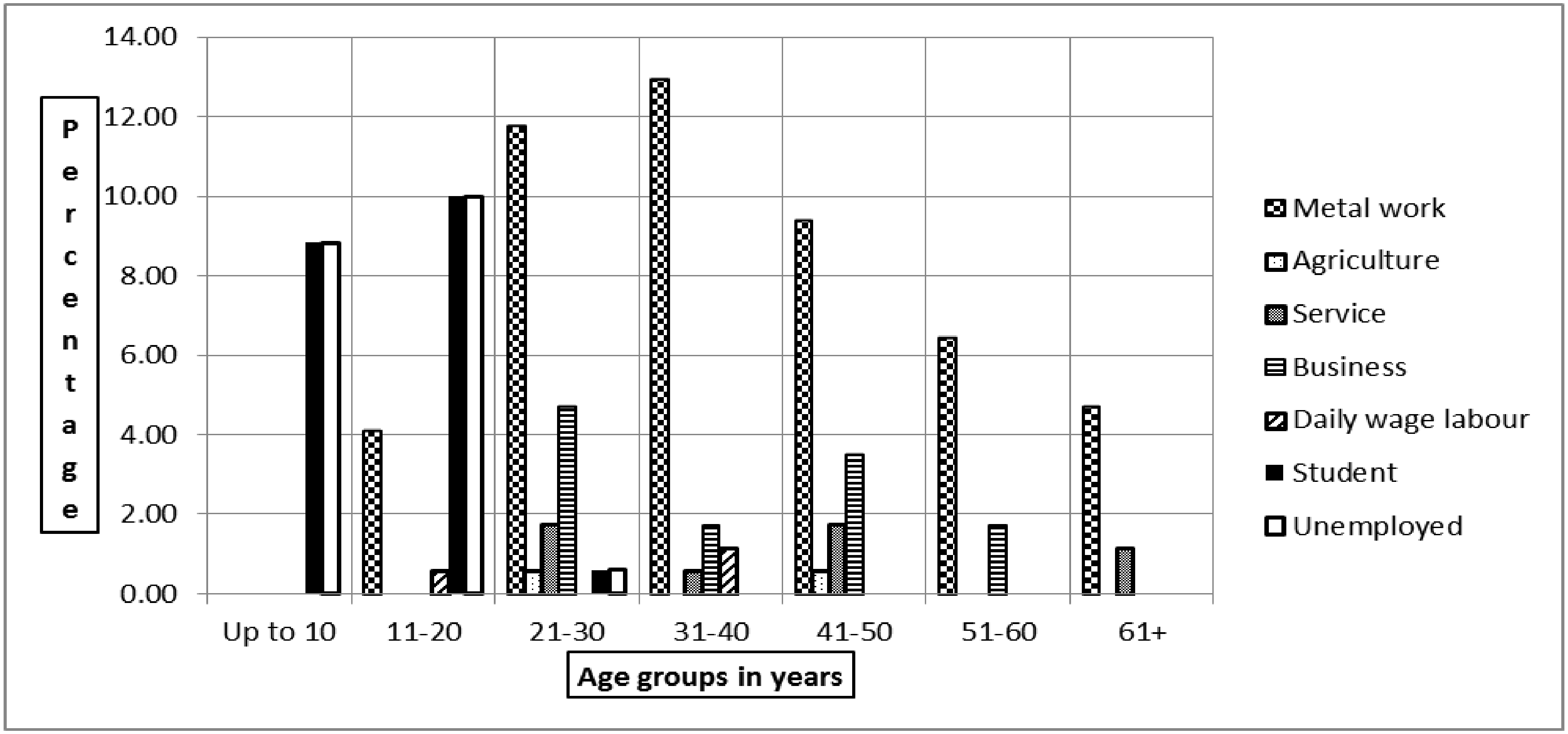


Table 15.2: Frequency distribution of occupational pattern in relation to age group of males in Shibalaya, W. B.

Age groups in years	Metal work		Occupations other than metal work												Total	
			Agriculture		Service		Business		Daily wage labour		Student		Unemployed			
	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%
Up to 10	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	51	6.44	51	6.44	102	12.88
11-20	28	3.54	0	0.00	0	0.00	1	0.13	0	0.00	78	9.85	11	1.39	118	14.90
21-30	119	15.03	0	0.00	12	1.52	26	3.28	1	0.13	8	1.01	13	1.64	179	22.60
31-40	107	13.51	0	0.00	4	0.51	29	3.66	3	0.38	0	0.00	3	0.38	146	18.43
41-50	94	11.87	0	0.00	1	0.13	20	2.53	2	0.25	0	0.00	0	0.00	117	14.77
51-60	44	5.56	0	0.00	2	0.25	18	2.27	1	0.13	0	0.00	3	0.38	68	8.59
61+	29	3.66	0	0.00	0	0.00	8	1.01	1	0.13	0	0.00	24	3.03	62	7.83
Total	421	53.16	0	0.00	19	2.40	102	12.88	8	1.01	137	17.30	105	13.26	792	100.00

Figure 32.2: Occupational pattern in relation to age group of males, Shibalaya, West Bengal

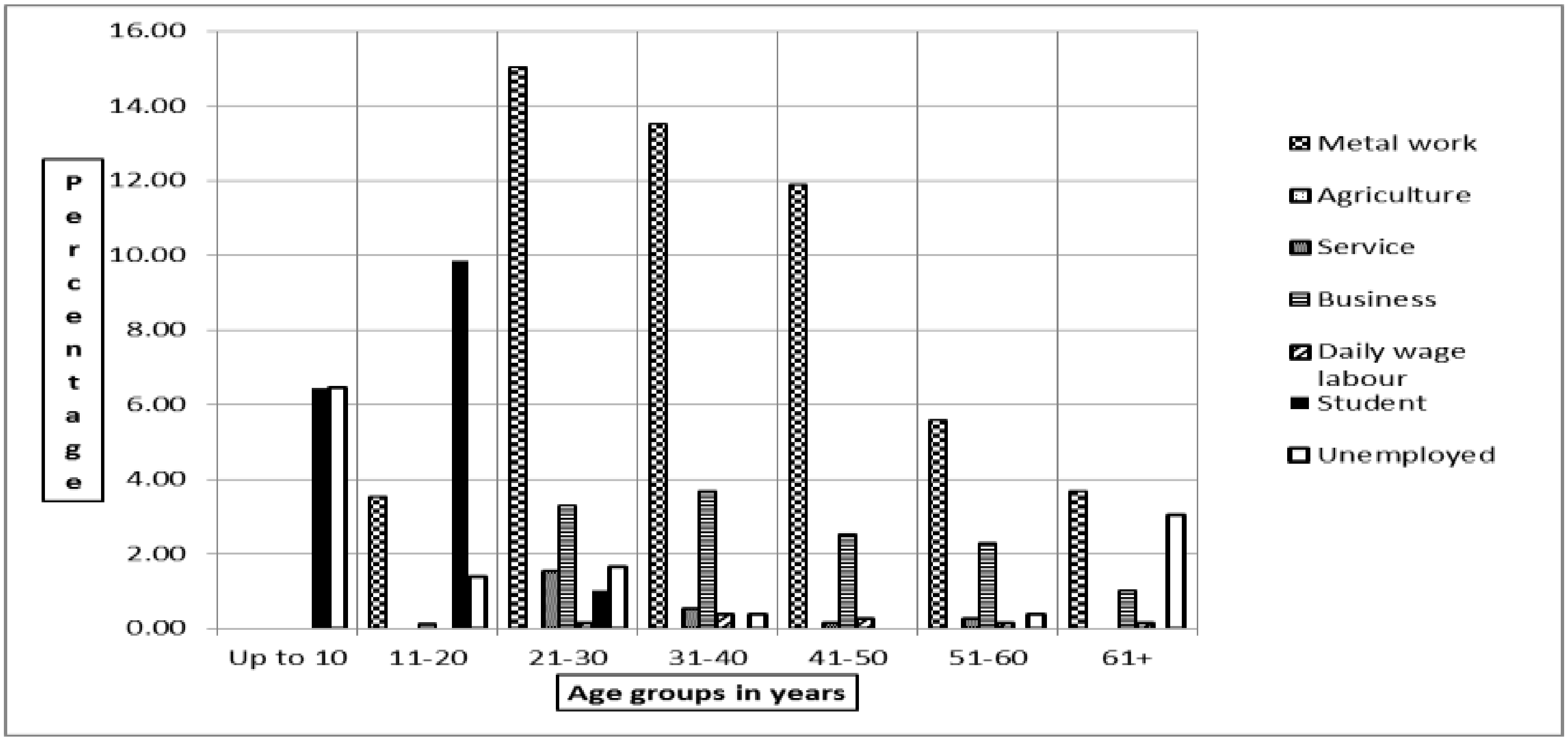


Table 15.3: Frequency distribution of occupational pattern in relation to age group of males in Bishnupur, W. B.

Age groups in years	Metal work		Occupations other than metal work												Total	
			Agriculture		Service		Business		Daily wage labour		Student		Unemployed			
	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%
Up to 10	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	21	6.86	15	4.90	36	11.76
11-20	0	0.00	0	0.00	0	0.00	4	1.31	3	0.98	31	10.13	1	0.33	39	12.75
21-30	8	2.61	0	0.00	4	1.31	25	8.17	14	4.58	2	0.65	16	5.23	69	22.55
31-40	17	5.56	0	0.00	6	1.96	23	7.52	11	3.59	0	0.00	1	0.33	58	18.95
41-50	16	5.23	0	0.00	8	2.61	18	5.88	3	0.98	0	0.00	1	0.33	46	15.03
51-60	6	1.96	0	0.00	9	2.94	12	3.92	3	0.98	0	0.00	3	0.98	33	10.78
61+	5	1.63	0	0.00	0	0.00	5	1.63	0	0.00	0	0.00	15	4.90	25	8.17
Total	52	16.99	0	0.00	27	8.82	87	28.43	34	11.11	54	17.65	52	16.99	306	100.00

Figure 32.3: Occupational pattern in relation to age group of males, Bishnupur, West Bengal

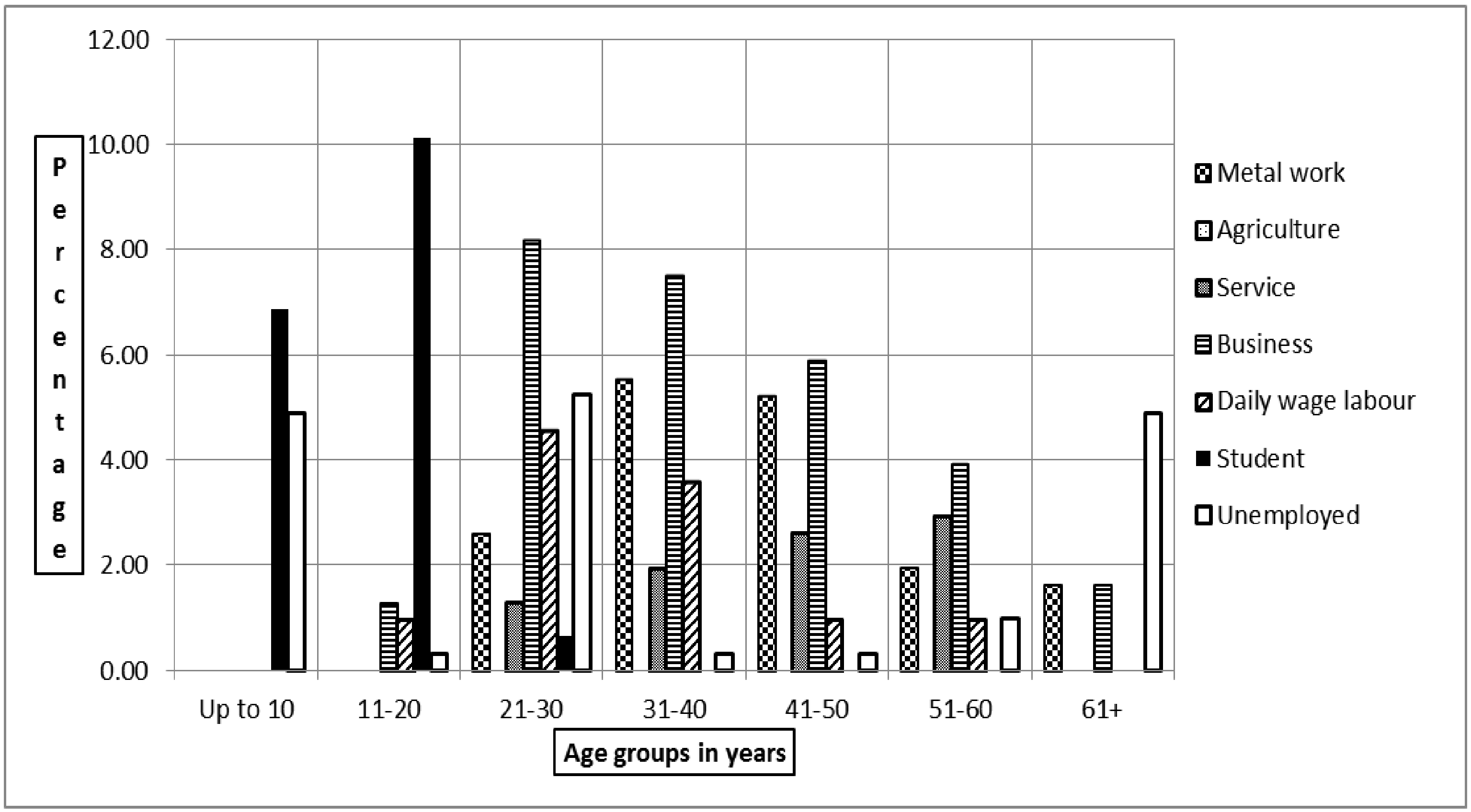


Table 15.4: Frequency distribution of occupational pattern in relation to age group of males in Bikna, W. B.

Age groups in years	Metal work		Occupations other than metal work												Total	
			Agriculture		Service		Business		Daily wage labour		Student		Unemployed			
	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%
Up to 10	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	19	14.29	26	19.55	45	33.83
11-20	19	14.29	0	0.00	0	0.00	0	0.00	0	0.00	5	3.76	0	0.00	24	18.05
21-30	33	24.81	0	0.00	0	0.00	1	0.75	0	0.00	0	0.00	0	0.00	34	25.56
31-40	11	8.27	0	0.00	0	0.00	0	0.00	1	0.75	0	0.00	0	0.00	12	9.02
41-50	10	7.52	0	0.00	0	0.00	3	2.26	0	0.00	0	0.00	0	0.00	13	9.77
51-60	5	3.76	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	5	3.76
61+	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Total	78	58.65	0	0.00	0	0.00	4	3.01	1	0.75	24	18.05	26	19.55	133	100.00

Figure 32.4: Occupational pattern in relation to age group of males, Bikna, West Bengal

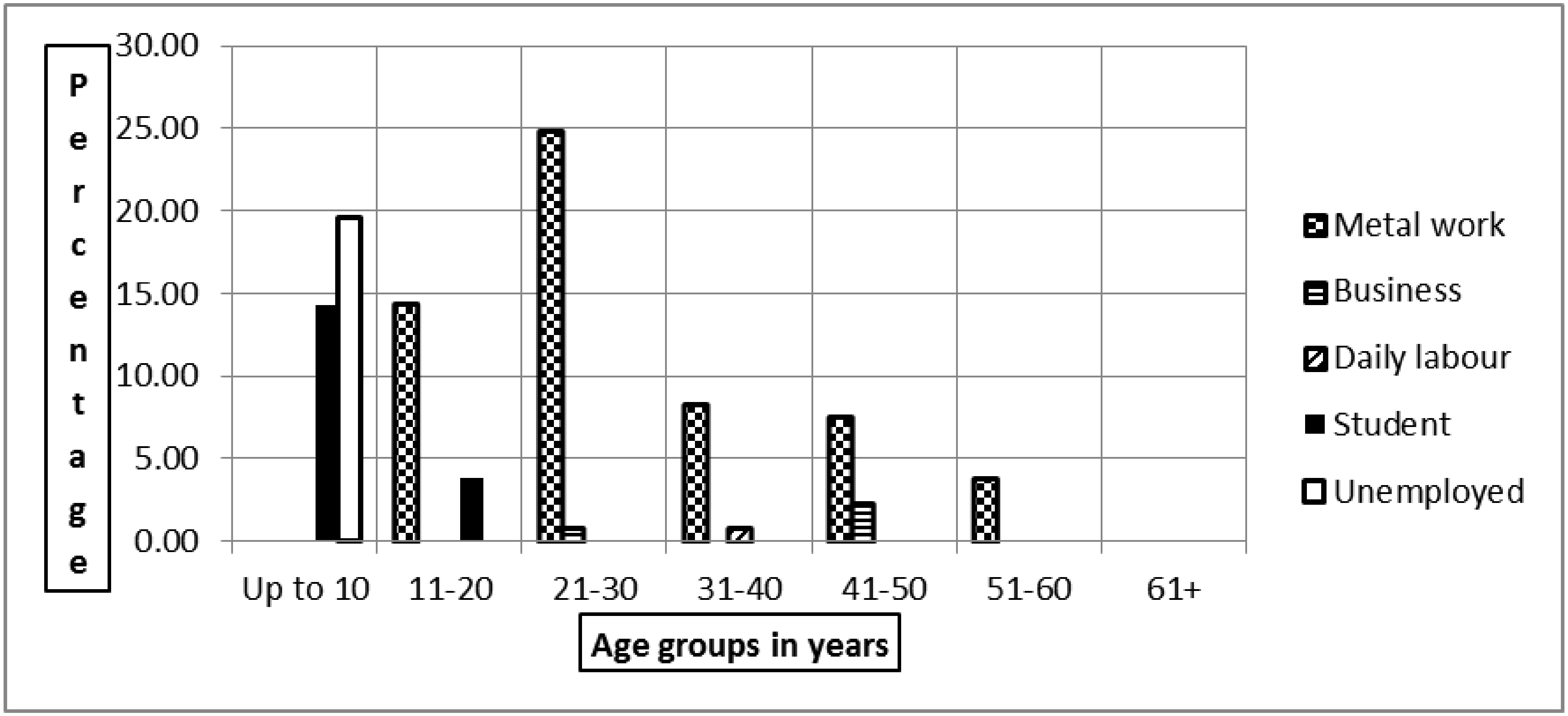


Table15.5: Frequency distribution of occupational pattern in relation to age group of males in Rathijemapatna, Odisha

Age groups in years	Metal work		Agriculture		Service		Business		Daily wage labour		Student		Unemployed		Total	
	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%
Up to 10	0	0.00	0	0.00	0	0.00	0	0.00	1	0.09	83	7.06	65	5.53	149	12.67
11-20	30	2.55	0	0.00	4	0.34	41	3.49	13	1.11	141	11.99	48	4.08	277	23.55
21-30	72	6.12	0	0.00	9	0.77	95	8.08	23	1.96	6	0.51	49	4.17	254	21.60
31-40	67	5.70	0	0.00	10	0.85	65	5.53	10	0.85	0	0.00	8	0.68	160	13.61
41-50	64	5.44	2	0.17	8	0.68	65	5.53	12	1.02	0	0.00	4	0.34	155	13.18
51-60	42	3.57	4	0.34	6	0.51	44	3.74	3	0.26	0	0.00	10	0.85	109	9.27
61+	36	3.06	0	0.00	1	0.09	4	0.34	6	0.51	0	0.00	25	2.13	72	6.12
Total	311	26.45	6	0.51	38	3.23	314	26.70	68	5.78	230	19.56	209	17.77	1176	100.00

Figure 32.5: Occupational pattern in relation to age group of males, Rathijemapatna, Odisha

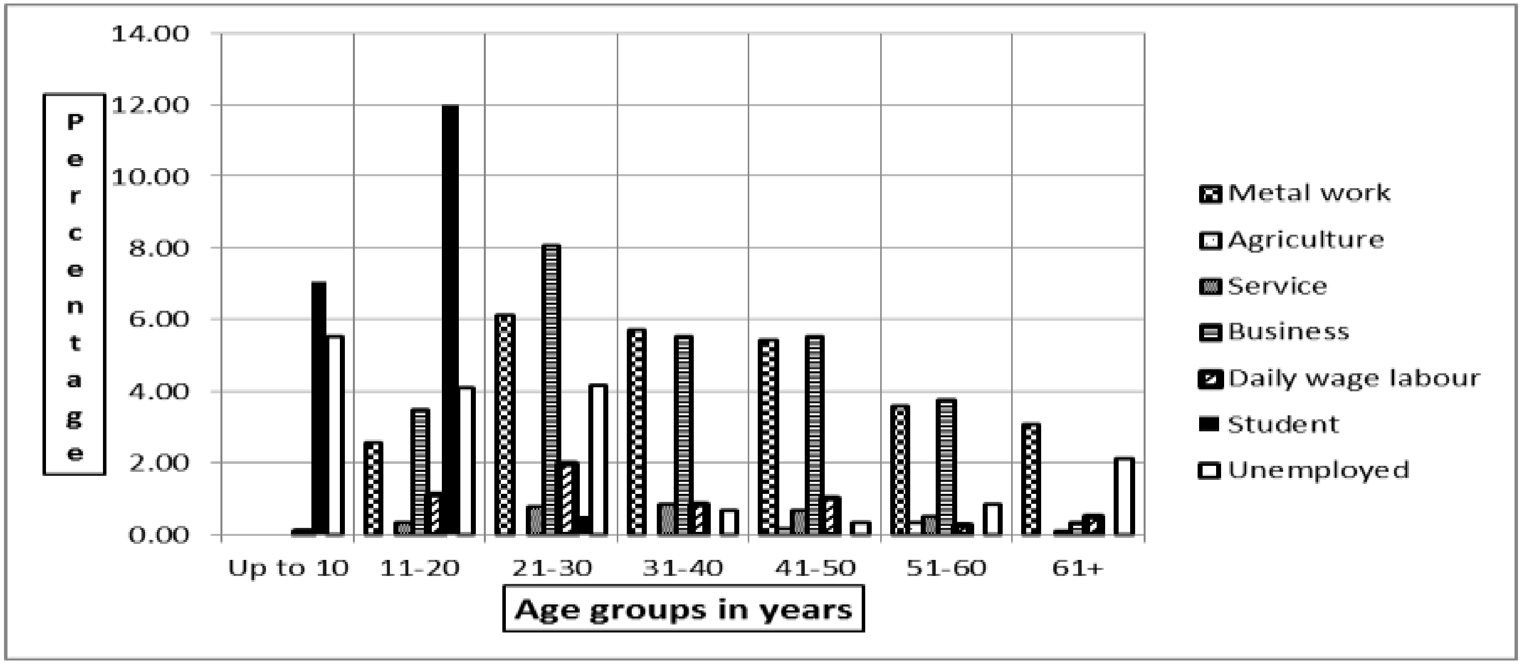


Table 15.6: Frequency distribution of occupational pattern in relation to age group of males in Sadeibereni, Odisha

Age groups in years	Metal work		Agriculture		Service		Business		Daily wage labour		Student		Unemployed		Total	
	No	**%**	**No**	**%**	**No**	**%**	**No**	**%**	**No**	**%**	**No**	**%**	**No**	**%**	**No**	**%**
Up to 10	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	23	13.07	19	10.80	42	23.87
11-20	25	14.20	0	0.00	0	0.00	0	0.00	3	1.70	5	2.84	0	0.00	33	18.75
21-30	28	15.91	0	0.00	0	0.00	0	0.00	3	1.70	0	0.00	0	0.00	31	17.61
31-40	26	14.77	0	0.00	0	0.00	0	0.00	7	3.98	0	0.00	0	0.00	33	18.75
41-50	18	10.23	0	0.00	0	0.00	0	0.00	5	2.84	0	0.00	0	0.00	23	13.07
51-60	6	3.41	0	0.00	0	0.00	1	0.57	1	0.57	0	0.00	2	1.14	10	5.68
61+	2	1.14	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	2	1.14	4	2.27
Total	105	59.66	0	0.00	0	0.00	1	0.57	19	10.79	28	15.91	23	13.08	176	100.00

Figure 32.6: Occupational pattern in relation to age group of males, Sadeibereni, Odisha

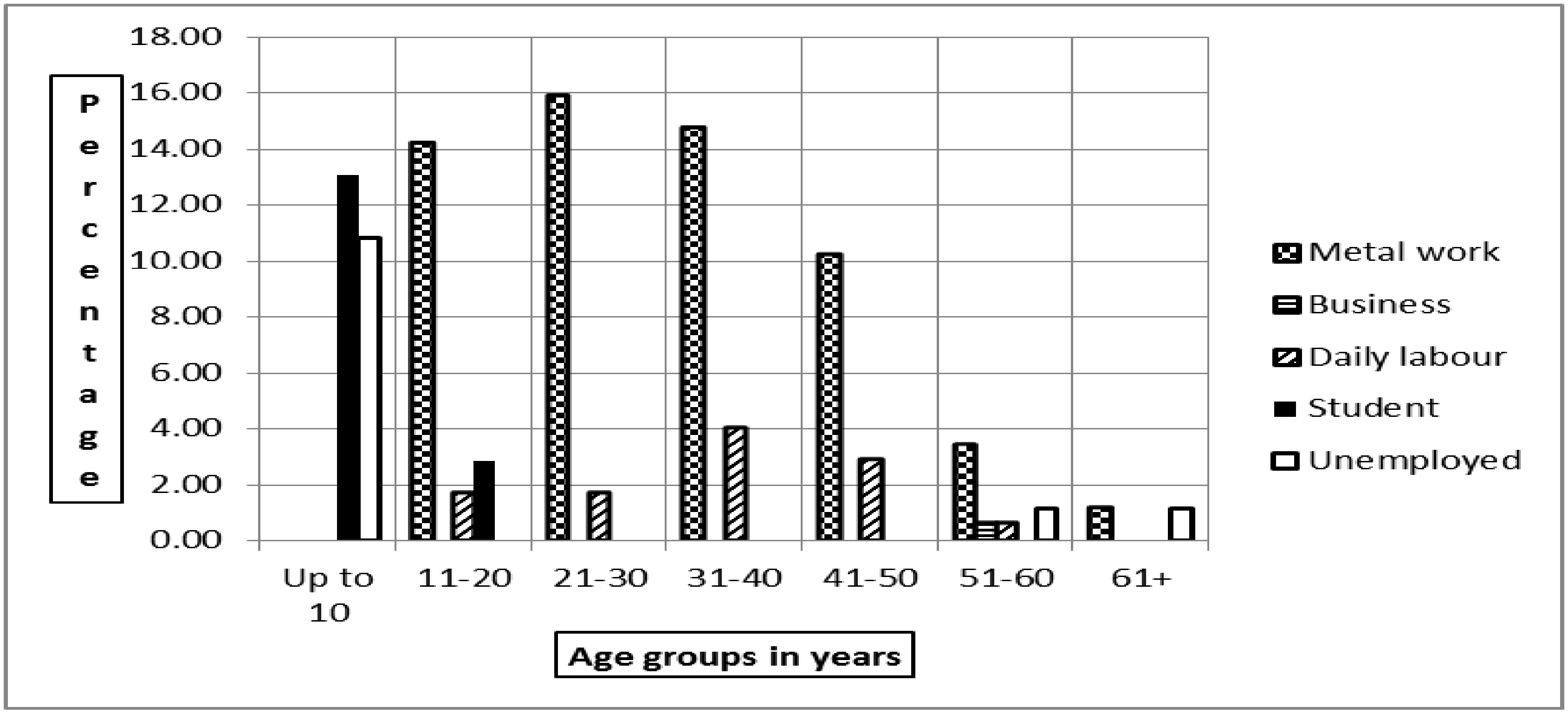


Table 16.1: Frequency distribution of occupational pattern in relation to age group of females of Berhampore, W. B.

Age group (in years)	Metal work		Occupations other than metal work												Total	
			Household work		Service		Business		Daily wage labour		Student		Unemployed			
	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%
Up to 10	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	8	5.93	8	5.93	16	11.85
11-20	0	0.00	4	2.96	0	0.00	0	0.00	0	0.00	14	10.37	0	0.00	18	13.33
21-30	0	0.00	39	28.89	0	0.00	1	0.74	0	0.00	6	4.44	0	0.00	46	34.07
31-40	0	0.00	18	13.33	0	0.00	1	0.74	0	0.00	0	0.00	0	0.00	19	14.07
41-50	0	0.00	18	13.33	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	18	13.33
51-60	0	0.00	11	8.15	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	11	8.15
61+	0	0.00	7	5.19	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	7	5.19
Total	0	0.00	97	71.85	0	0.00	2	1.48	0	0.00	28	20.74	8	5.93	135	100.00

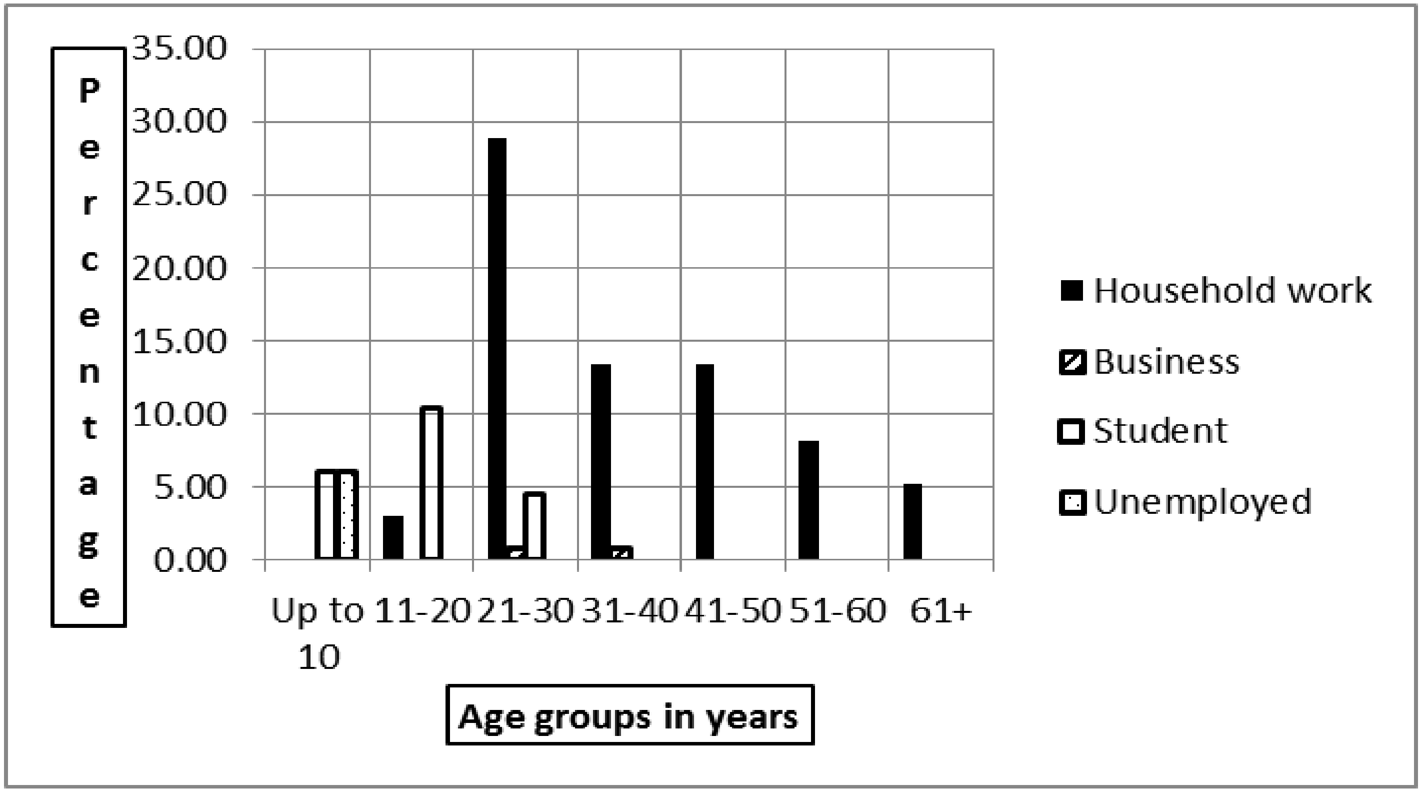


Figure 33.1: Occupational pattern of females, Berhampore, W.B.

Table 16.2: Frequency distribution of occupational pattern in relation to age group of females of Shibalaya, W. B.

Age group (in years)	Household work + Metal related work		Occupations other than metal work												Total	
			Household work		Service		Business		Daily wage labour		Student		Unemployed			
	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%
Up to 10	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	44	6.46	50	7.34	94	13.80
11-20	16	2.35	21	3.08	0	0.00	6	0.88	0	0.00	80	11.75	0	0.00	123	18.06
21-30	60	8.81	86	12.63	0	0.00	9	1.32	0	0.00	8	1.17	0	0.00	163	23.94
31-40	52	7.64	58	8.52	2	0.29	3	0.44	0	0.00	0	0.00	0	0.00	115	16.89
41-50	28	4.11	54	7.93	0	0.00	4	0.59	0	0.00	0	0.00	0	0.00	86	12.63
51-60	16	2.35	26	3.82	0	0.00	3	0.44	0	0.00	0	0.00	0	0.00	45	6.61
61+	7	1.03	48	7.05	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	55	8.08
Total	179	26.29	293	43.03	2	0.29	25	3.67	0	0.00	132	19.38	50	7.34	681	100.00

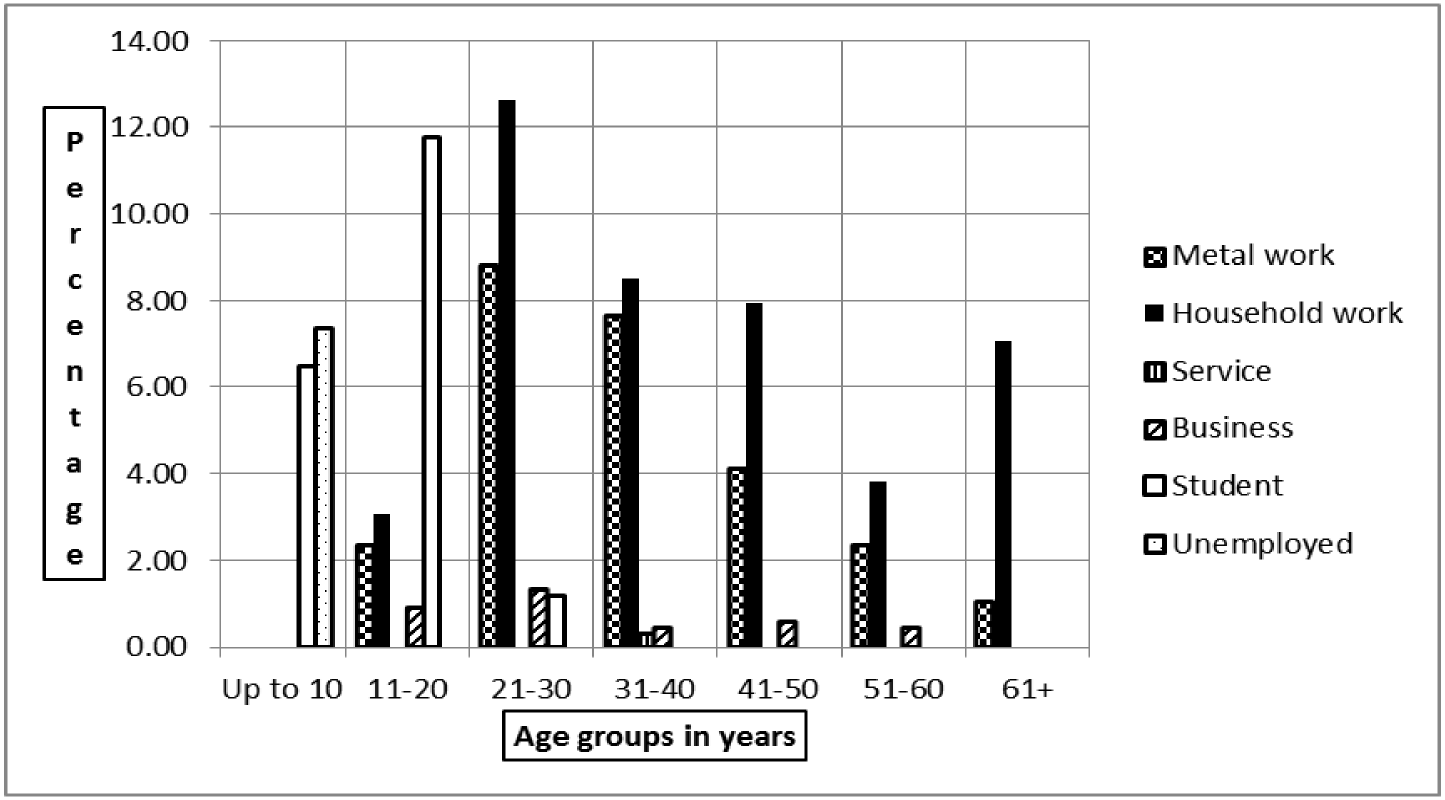


Figure 33.2: Occupational pattern of females, Shibalaya, W.B.

Table 16.3: Frequency distribution of occupational pattern in relation to age group of females of Bishnupur, W. B.

Age group (in years)	Household work + Metal related work		Occupations other than metal work												Total	
			Household work		Service		Business		Daily wage labour		Student		Unemployed			
	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%
Up to 10	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	16	5.93	14	5.19	30	11.11
11-20	0	0.00	11	4.07	0	0.00	0	0.00	0	0.00	34	12.59	0	0.00	45	16.67
21-30	5	1.85	45	16.67	1	0.37	3	1.11	0	0.00	1	0.37	0	0.00	55	20.37
31-40	10	3.70	35	12.96	1	0.37	5	1.85	1	0.37	0	0.00	0	0.00	52	19.26
41-50	2	0.74	38	14.07	0	0.00	1	0.37	0	0.00	0	0.00	0	0.00	41	15.19
51-60	1	0.37	26	9.63	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	27	10.00
61+	0	0.00	20	7.41	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	20	7.41
Total	18	6.67	175	64.81	2	0.74	9	3.33	1	0.37	51	18.89	14	5.19	270	100.00

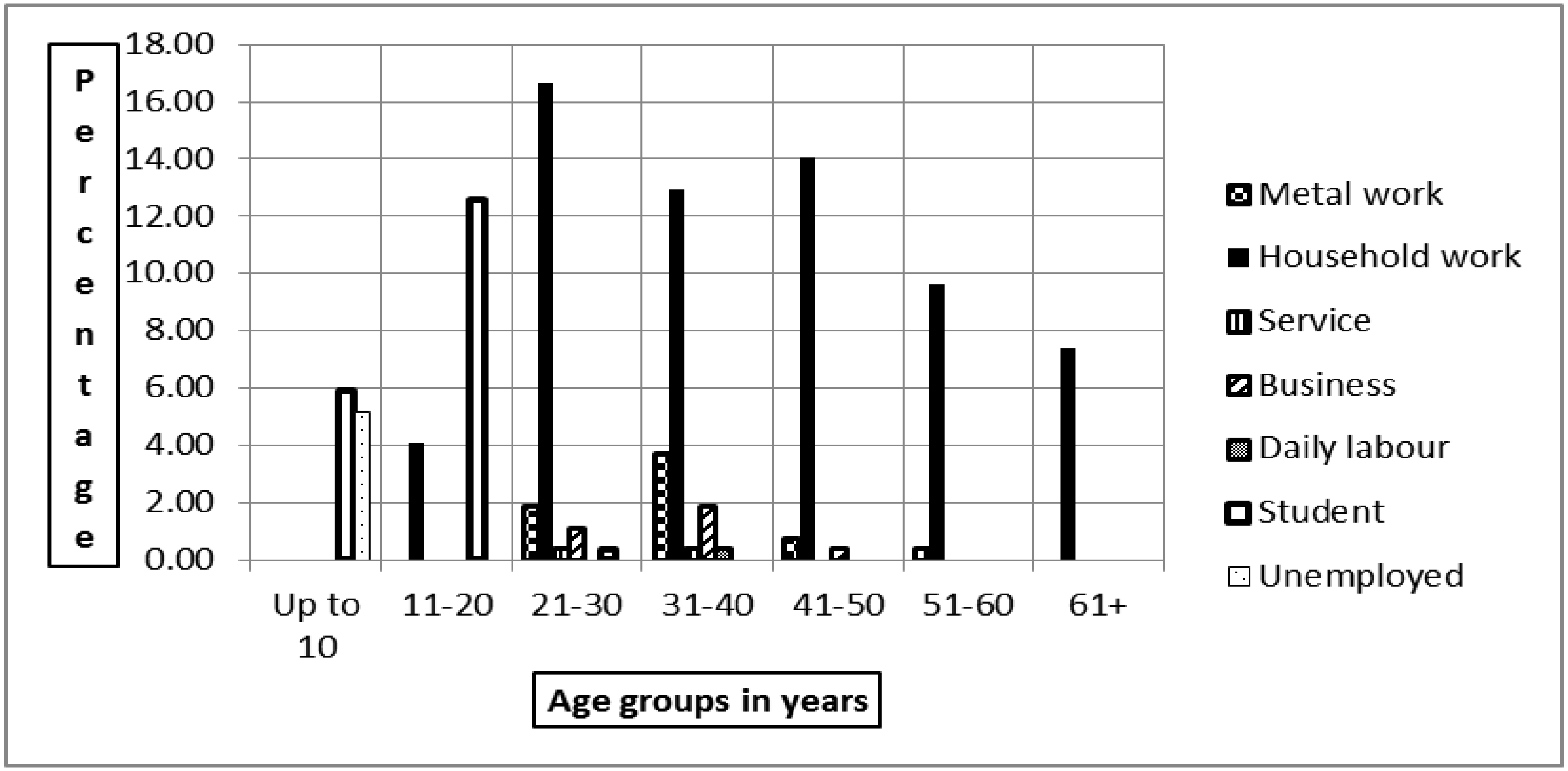


Figure 33.3: Occupational pattern of females, Bishnupur, W.B.

Table 16.4: Frequency distribution of occupational pattern in relation to age group of females of Bikna, W. B.

Age group (in years)	Household work + Metal related work		Others												Total	
			Household work		Service		Business		Daily wage labour		Student		Unemployed			
	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%
Up to 10	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	19	13.48	29	20.57	48	34.04
11-20	23	16.31	1	0.71	0	0.00	0	0.00	0	0.00	5	3.55	0	0.00	29	20.57
21-30	28	19.86	1	0.71	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	29	20.57
31-40	11	7.80	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	11	7.80
41-50	17	12.06	1	0.71	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	18	12.77
51-60	3	2.13	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	3	2.13
61+	3	2.13	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	3	2.13
Total	85	60.28	3	2.13	0	0.00	0	0.00	0	0.00	24	17.02	29	20.57	141	100.00

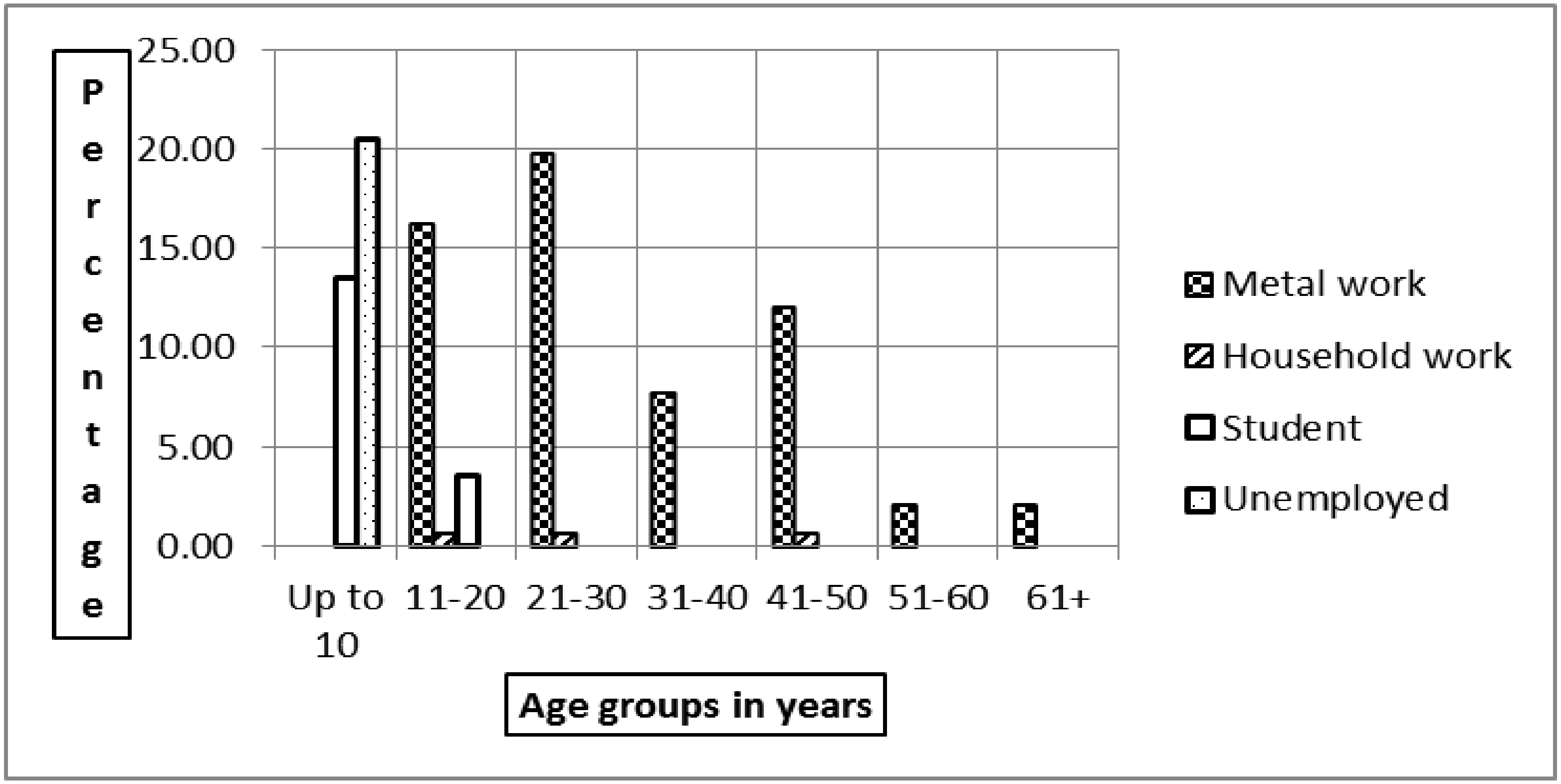


Figure 33.4: Occupational pattern of females, Bikna, W.B.

Table16.5: Frequency distribution of occupational pattern in relation to age group of females of Rathijemapatna, Odisha

Age group (in years)	Household work + Metal related work		Others												Total	
			Household work		Service		Business		Daily wage labour		Student		Unemployed			
	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%
Up to 10	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	81	7.30	90	8.11	171	15.41
11-20	0	0.00	98	8.83	0	0.00	1	0.09	0	0.00	163	14.68	0	0.00	262	23.60
21-30	0	0.00	199	17.93	1	0.09	4	0.36	0	0.00	6	0.54	0	0.00	210	18.92
31-40	0	0.00	159	14.32	0	0.00	1	0.09	0	0.00	0	0.00	0	0.00	160	14.41
41-50	0	0.00	144	12.97	0	0.00	2	0.18	0	0.00	0	0.00	0	0.00	146	13.15
51-60	0	0.00	80	7.21	0	0.00	2	0.18	0	0.00	0	0.00	0	0.00	82	7.39
61+	0	0.00	76	6.85	0	0.00	3	0.27	0	0.00	0	0.00	0	0.00	79	7.12
Total	0	0.00	756	68.11	1	0.09	13	1.17	0	0.00	250	22.52	90	8.11	1110	100.00

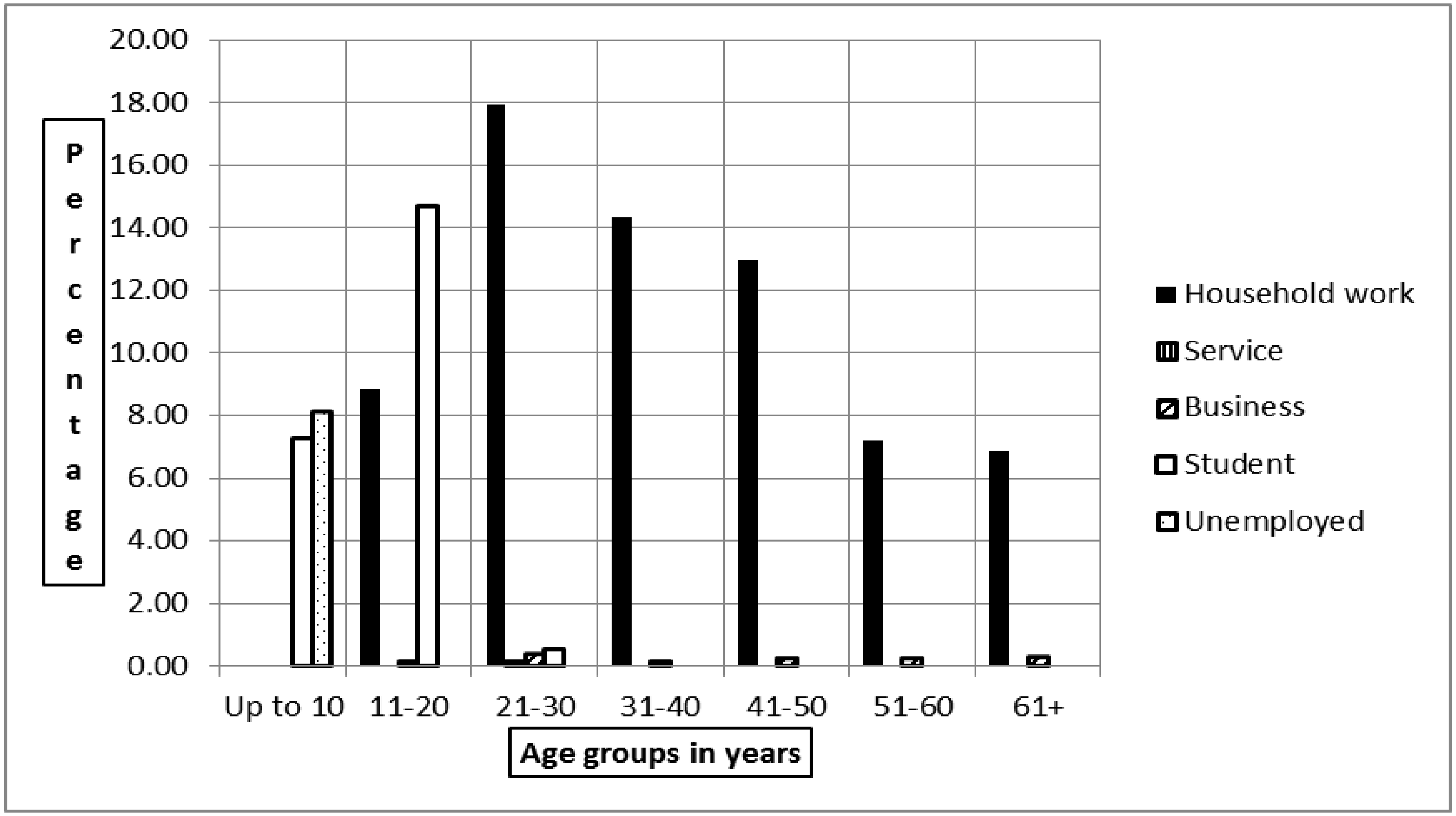


Figure 33.5: Occupational pattern of females, Rathijemapatna, Odisha

Table 16.6: Frequency distribution of occupational pattern in relation to age group of females of Sadeibereni, Odisha

Age group (in years)	Household work + Metal related work		Occupations other than metal work												Total	
			Household work		Service		Business		Daily wage labour		Student		Unemployed			
	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%
Up to 10	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	14	8.28	23	13.61	37	21.89
11-20	39	23.08	0	0.00	0	0.00	0	0.00	0	0.00	6	3.55	0	0.00	45	26.63
21-30	31	18.34	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	31	18.34
31-40	30	17.75	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	30	17.75
41-50	20	11.83	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	20	11.83
51-60	3	1.78	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	3	1.78
61+	1	0.59	0	0.00	0	0.00	1	0.59	0	0.00	0	0.00	1	0.59	3	1.78
Total	124	73.37	0	0.00	0	0.00	1	0.59	0	0.00	20	11.83	24	14.20	169	100.00

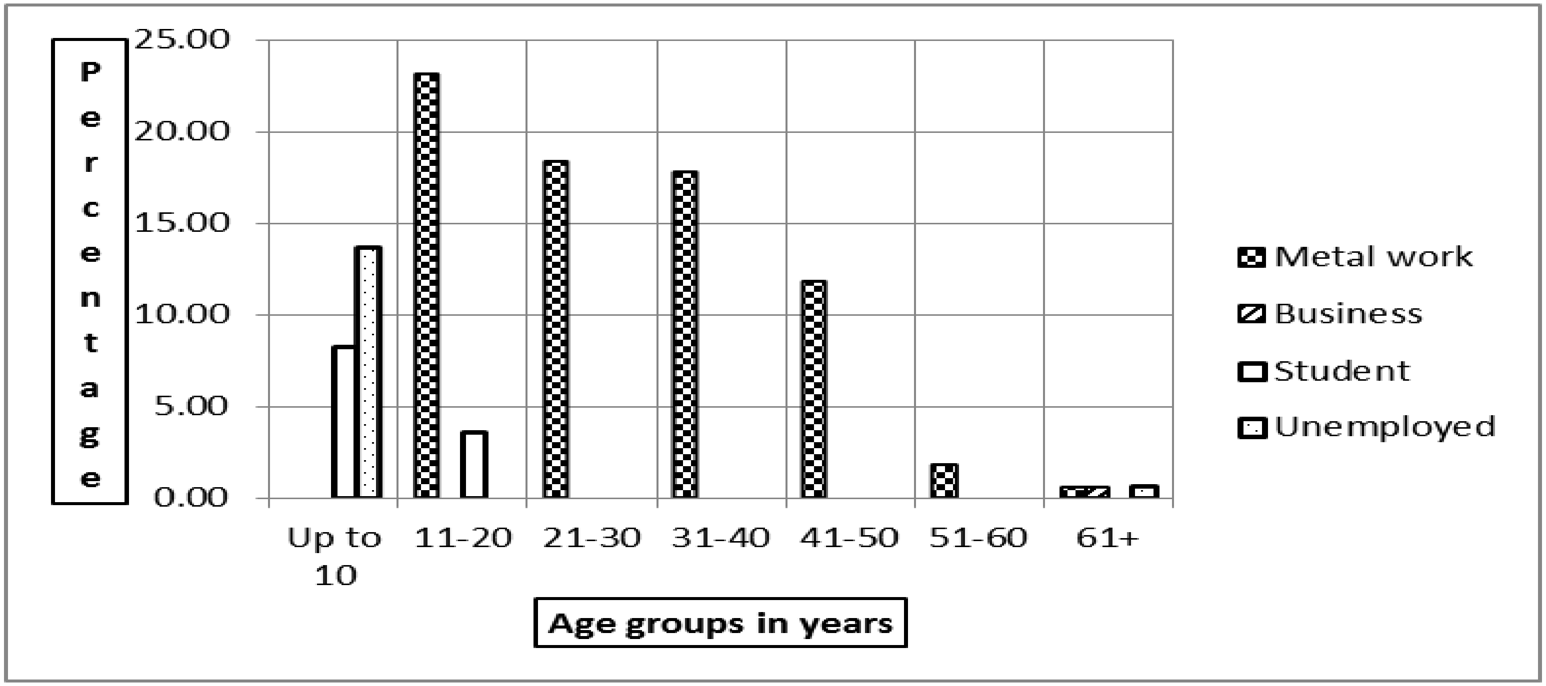


Figure 33.6: Occupational pattern of females, Sadeibereni, Odisha

Table 17.1: Frequency distribution of artisans (male) in relation to educational qualification in Berhampore, W. B.

Age groups In years	Educational standard												Total	
	Illiterate		Can sign		Primary		Secondary		Higher secondary		Graduate +			
	No	%	No	%	No	%	No	%	No	%	No	%	No	%
11-20	0	0.00	0	0.00	0	0.00	5	5.95	2	2.38	0	0.00	7	8.33
21-30	0	0.00	0	0.00	0	0.00	11	13.10	7	8.33	2	2.38	20	23.81
31-40	0	0.00	1	1.19	1	1.19	17	20.24	3	3.57	0	0.00	22	26.19
41-50	0	0.00	2	2.38	4	4.76	8	9.52	2	2.38	0	0.00	16	19.05
51-60	0	0.00	3	3.57	2	2.38	5	5.95	1	1.19	0	0.00	11	13.10
61+	0	0.00	3	3.57	0	0.00	4	4.76	1	1.19	0	0.00	8	9.52
Total	0	0.00	9	10.71	7	8.33	50	59.52	16	19.05	2	2.38	84	100.00

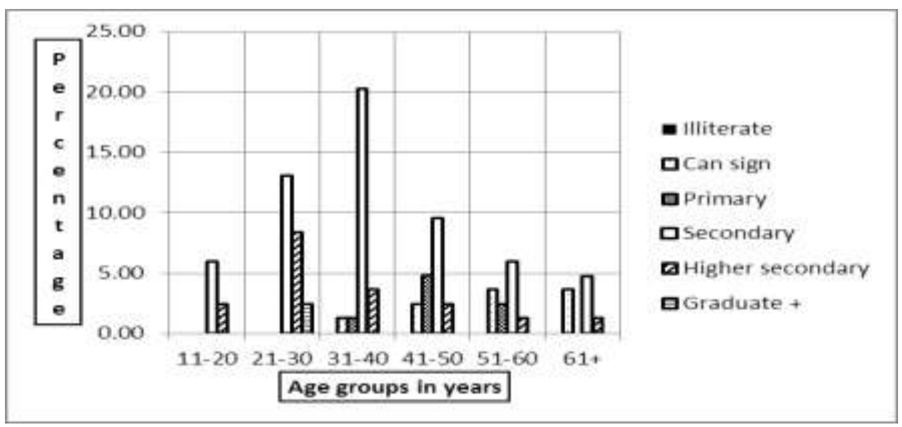


Figure 34.1: Education qualification of artisans, Berhampore, W.B.

Table 17.2: Frequency distribution of artisans (male) in relation to educational qualification in Shibalaya, W. B.

Age groups In years	Educational standard												Total	
	Illiterate		Can sign		Primary		Secondary		Higher secondary		Graduate +			
	No	%	No	%	No	%	No	%	No	%	No	%	No	%
11-20	2	0.48	0	0.00	3	0.71	20	4.75	2	0.48	1	0.24	28	6.65
21-30	4	0.95	4	0.95	4	0.95	93	22.09	11	2.61	3	0.71	119	28.27
31-40	6	1.43	20	4.75	8	1.90	60	14.25	8	1.90	5	1.19	107	25.42
41-50	13	3.09	25	5.94	5	1.19	51	12.11	0	0.00	0	0.00	94	22.33
51-60	5	1.19	17	4.04	5	1.19	13	3.09	1	0.24	3	0.71	44	10.45
61+	5	1.19	11	2.61	4	0.95	7	1.66	1	0.24	1	0.24	29	6.89
Total	35	8.31	77	18.29	29	6.89	244	57.96	23	5.46	13	3.09	421	100.00

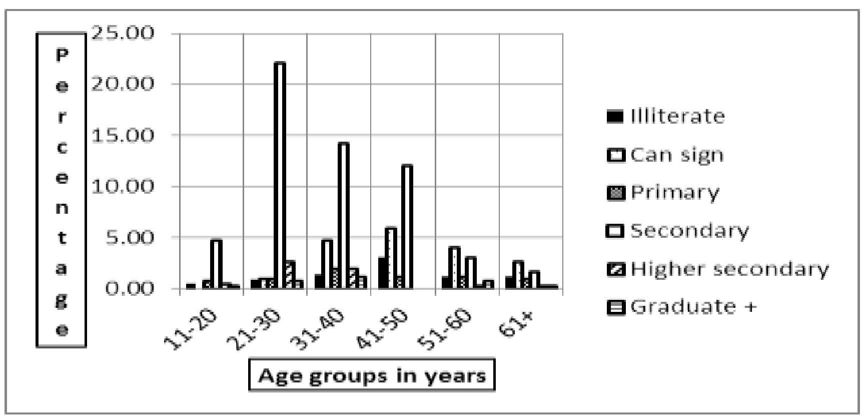


Figure 34.2: Education qualification of artisans, Shibalaya, W.B.

Table 17.3: Frequency distribution of artisans (male) in relation to educational qualification in Bishnupur, W. B.

Age groups In years	Educational standard												Total	
	Illiterate		Can sign		Primary		Secondary		Higher secondary		Graduate +			
	No	%	No	%	No	%	No	%	No	%	No	%	No	%
11-20	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
21-30	0	0.00	0	0.00	0	0.00	6	11.54	2	3.85	0	0.00	8	15.38
31-40	2	3.85	0	0.00	2	3.85	10	19.23	1	1.92	2	3.85	17	32.69
41-50	0	0.00	3	5.77	3	5.77	7	13.46	1	1.92	2	3.85	16	30.77
51-60	0	0.00	0	0.00	2	3.85	3	5.77	0	0.00	1	1.92	6	11.54
61+	0	0.00	1	1.92	2	3.85	1	1.92	1	1.92	0	0.00	5	9.62
Total	2	3.85	4	7.69	9	17.31	27	51.92	5	9.61	5	9.62	52	100.00

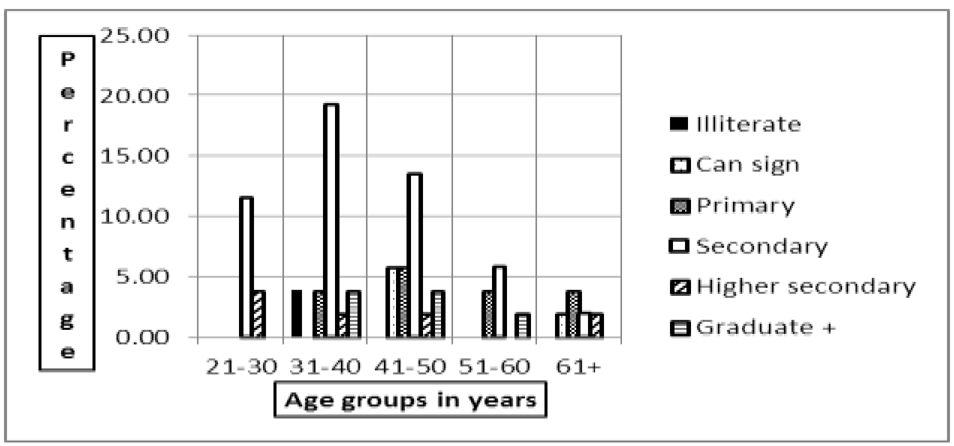


Figure 34.3: Education qualification of artisans, Bishnupur, W.B.

Table 17.4: Frequency distribution of artisans (male) in relation to educational qualification in Bikna, W. B.

Age groups In years	Educational standard												Total	
	Illiterate		Can sign		Primary		Secondary		Higher secondary		Graduate +			
	No	%	No	%	No	%	No	%	No	%	No	%	No	%
11-20	0	0.00	3	3.85	11	14.10	5	6.41	0	0.00	0	0.00	19	24.36
21-30	1	1.28	5	6.41	16	20.51	11	14.10	0	0.00	0	0.00	33	42.31
31-40	2	2.56	3	3.85	2	2.56	4	5.13	0	0.00	0	0.00	11	14.10
41-50	3	3.85	4	5.13	2	2.56	1	1.28	0	0.00	0	0.00	10	12.82
51-60	1	1.28	1	1.28	2	2.56	1	1.28	0	0.00	0	0.00	5	6.41
61+	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Total	7	8.97	16	20.51	33	42.31	22	28.21	0	0.00	0	0.00	78	100.00

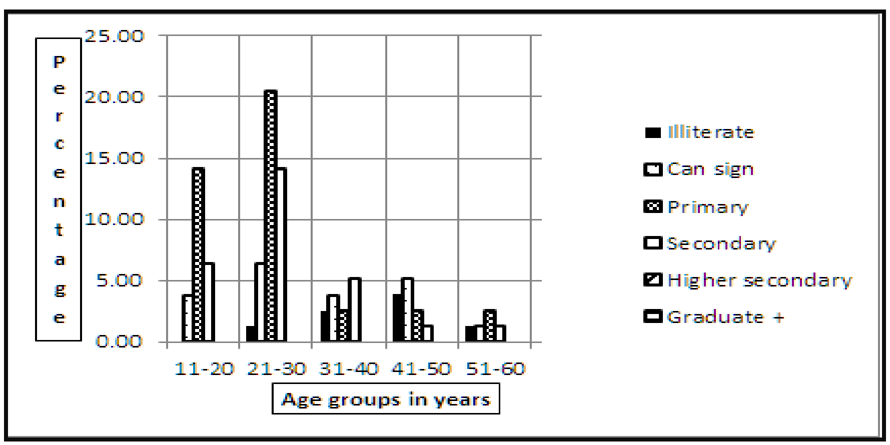


Figure 34.4: Education qualification of artisans, Bikna, W.B.

Table 17.5: Frequency distribution of artisans (male) in relation to educational qualification in Rathijemapatna, Odisha

Age groups In years	Educational standard												Total	
	Illiterate		Can sign		Primary		Secondary		Higher secondary		Graduate +			
	No	%	No	%	No	%	No	%	No	%	No	%	No	%
11-20	1	0.32	1	0.32	4	1.29	20	6.43	4	1.29	0	0.00	30	9.65
21-30	1	0.32	2	0.64	8	2.57	51	16.40	6	1.93	4	1.29	72	23.15
31-40	3	0.96	4	1.29	17	5.47	39	12.54	1	0.32	3	0.96	67	21.54
41-50	4	1.29	6	1.93	11	3.54	43	13.83	0	0.00	0	0.00	64	20.58
51-60	3	0.96	9	2.89	14	4.50	16	5.14	0	0.00	0	0.00	42	13.50
61+	6	1.93	15	4.82	9	2.89	5	1.61	1	0.32	0	0.00	36	11.58
Total	18	5.78	37	11.90	63	20.26	174	55.95	12	3.86	7	2.25	311	100.00

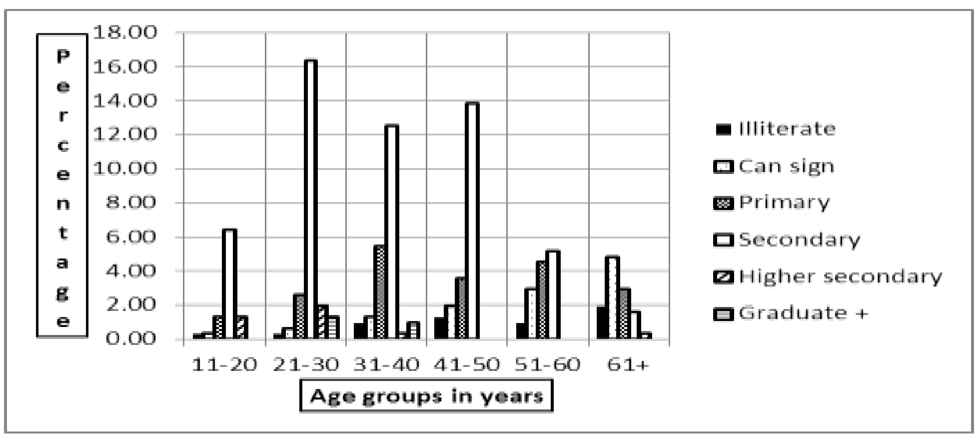


Figure 34.5: Education qualification of artisans, Rathijema, Odisha.

Table 17.6: Frequency distribution of artisans (male) in relation to educational qualification in Sadeibereni, Odisha

Age groups In years	Educational standard												Total	
	Illiterate		Can sign		Primary		Secondary		Higher secondary		Graduate +			
	No	%	No	%	No	%	No	%	No	%	No	%	No	%
11-20	5	4.76	2	1.90	5	4.76	13	12.38	0	0.00	0	0.00	25	23.81
21-30	2	1.90	8	7.62	9	8.57	9	8.57	0	0.00	0	0.00	28	26.67
31-40	5	4.76	6	5.71	2	1.90	13	12.38	0	0.00	0	0.00	26	24.76
41-50	8	7.62	5	4.76	2	1.90	3	2.86	0	0.00	0	0.00	18	17.14
51-60	3	2.86	3	2.86	0	0.00	0	0.00	0	0.00	0	0.00	6	5.71
61+	1	0.95	0	0.00	0	0.00	1	0.95	0	0.00	0	0.00	2	1.90
Total	24	22.86	24	22.86	18	17.14	39	37.14	0	0.00	0	0.00	105	100.00

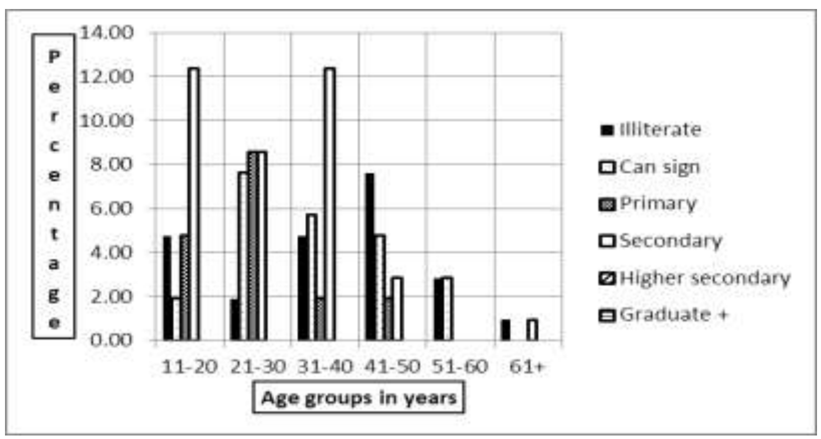


Figure 34.6: Education qualification of artisans, Sadeibereni, Odisha

Table 18.1: Frequency distribution of artisans (male) according to mode work in Berhampore, W. B.

Age groups in years	Artisan labour		Artisan		Others related to the craft		Total	
	No	%	No	%	No	%	No	%
Up to 10	0	0.00	0	0.00	0	0.00	0	0.00
11-20	2	2.38	3	3.57	2	2.38	7	8.33
21-30	1	1.19	8	9.52	11	13.10	20	23.81
31-40	1	1.19	15	17.86	6	7.14	22	26.19
41-50	2	2.38	10	11.90	4	4.76	16	19.05
51-60	2	2.38	6	7.14	3	3.57	11	13.10
60+	2	2.38	3	3.57	3	3.57	8	9.52
Total	10	11.90	45	53.57	29	34.52	84	100.00

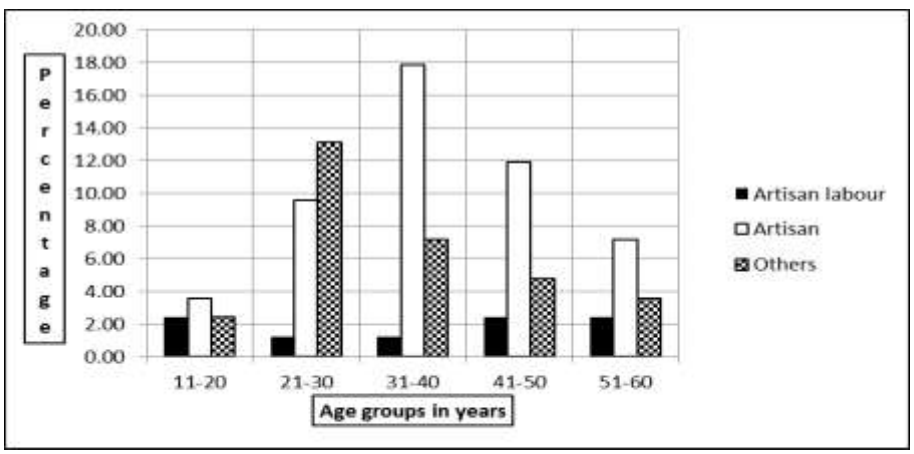


Figure 35.1: Mode of work of artisans of Berhampore, W.B.

Table 18.2: Frequency distribution of artisans (male) according to mode work in Shibalaya, West Bengal

Age groups in years	Artisan labour		Artisan		Others related to the craft		Total	
	No	%	No	%	No	%	No	%
Up to 10	0	0.00	0	0.00	0	0.00	0	0.00
11-20	16	3.80	10	2.38	2	0.48	28	6.65
21-30	47	11.16	70	16.63	2	0.48	119	28.27
31-40	48	11.40	58	13.78	1	0.24	107	25.42
41-50	46	10.93	48	11.40	0	0.00	94	22.33
51-60	10	2.38	34	8.08	0	0.00	44	10.45
60+	4	0.95	25	5.94	0	0.00	29	6.89
Total	171	40.62	245	58.19	5	1.19	421	100.00

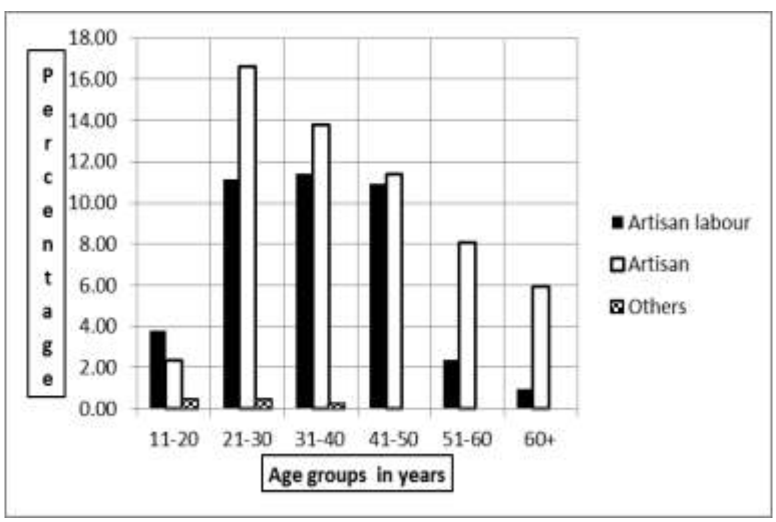


Figure 35.2: Mode of work of artisans of Shibalaya, W.B.

Table 18.3: Frequency distribution of artisan (male) according to mode work in Bishnupur, West Bengal

Age groups in years	Artisan labour		Artisan		Others related to the craft		Total	
	No	%	No	%	No	%	No	%
Up to 10	0	0.00	0	0.00	0	0.00	0	0.00
11-20	0	0.00	0	0.00	0	0.00	0	0.00
21-30	0	0.00	7	13.46	1	1.92	8	15.38
31-40	0	0.00	13	25.00	4	7.69	17	32.69
41-50	0	0.00	14	26.92	2	3.85	16	30.77
51-60	0	0.00	5	9.62	1	1.92	6	11.54
60+	0	0.00	4	7.69	1	1.92	5	9.62
Total	0	0.00	43	82.69	9	17.31	52	100.00

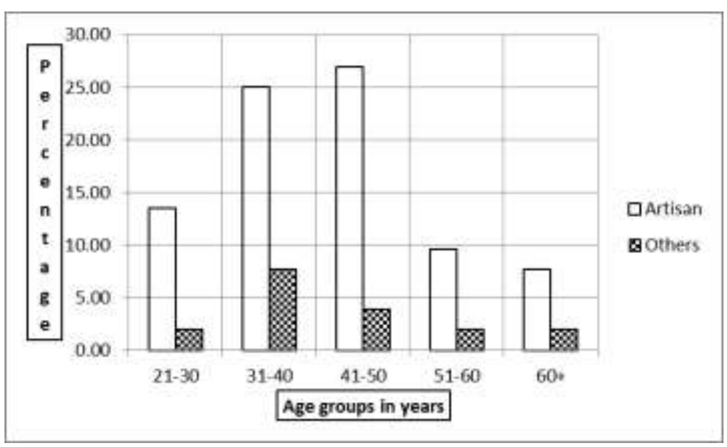


Figure 35.3: Mode of work of artisans of Bishnupur, W.B.

Table 18.4: Frequency distribution of artisan (male) according to mode work in Bikna, West Bengal

Age groups in years	Artisan labour		Artisan		Others related to the craft		Total	
	No	%	No	%	No	%	No	%
Up to 10	0	0.00	2	2.38	0	0.00	2	2.38
11-20	0	0.00	23	27.38	0	0.00	23	27.38
21-30	0	0.00	33	39.29	0	0.00	33	39.29
31-40	0	0.00	11	13.10	0	0.00	11	13.10
41-50	0	0.00	9	10.71	1	1.19	10	11.90
51-60	0	0.00	5	5.95	0	0.00	5	5.95
60+	0	0.00	0	0.00	0	0.00	0	0.00
Total	0	0.00	83	98.81	1	1.19	84	100.00

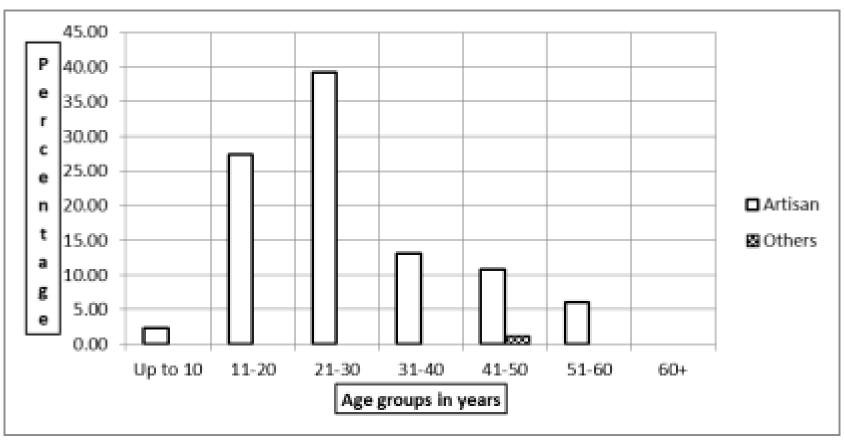


Figure 35.4: Mode of work of artisans of Bikna, W.B.

Table 18.5: Frequency distribution of artisans (male) according to mode work in Rathijemapatna, Odisha

Age groups in years	Artisan labour		Artisan		Others related to the craft		Total	
	No	%	No	%	No	%	No	%
Up to 10	0	0.00	0	0.00	0	0.00	0	0.00
11-20	21	6.75	9	2.89	0	0.00	30	9.65
21-30	44	14.15	28	9.00	0	0.00	72	23.15
31-40	42	13.50	25	8.04	0	0.00	67	21.54
41-50	35	11.25	29	9.32	0	0.00	64	20.58
51-60	20	6.43	22	7.07	0	0.00	42	13.50
60+	14	4.50	21	6.75	1	0.32	36	11.58
Total	176	56.59	134	43.09	1	0.32	311	100.00

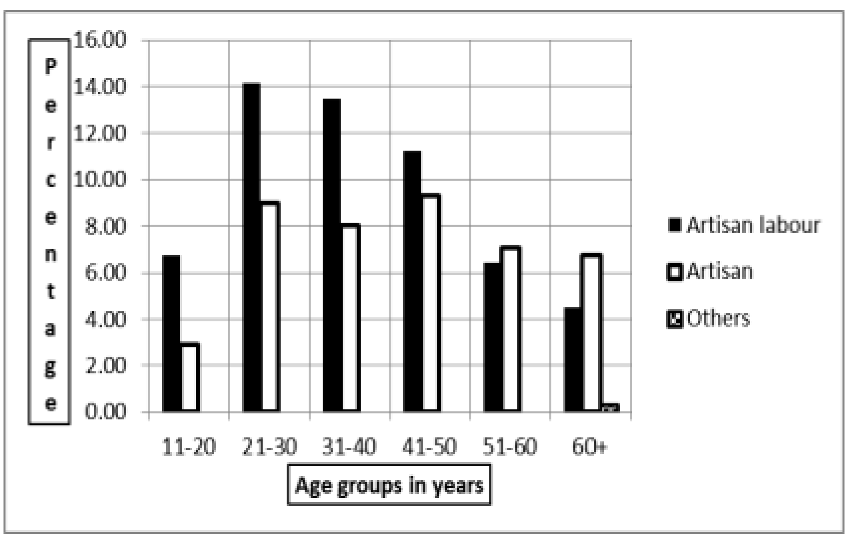


Figure 35.5: Mode of work of artisans of Rathijema, Odisha

Table 18.6: Frequency distribution of artisan (male) according to mode work in Sadeibereni, Odisha

Age groups in years	Artisan labour		Artisan		Others related to the craft		Total	
	No	%	No	%	No	%	No	%
Up to 10	0	0.00	7	6.03	0	0.00	7	6.03
11-20	0	0.00	29	25.00	0	0.00	29	25.00
21-30	0	0.00	28	24.14	0	0.00	28	24.14
31-40	0	0.00	26	22.41	0	0.00	26	22.41
41-50	0	0.00	18	15.52	0	0.00	18	15.52
51-60	0	0.00	6	5.17	0	0.00	6	5.17
60+	0	0.00	2	1.72	0	0.00	2	1.72
Total	0	0.00	116	100.00	0	0.00	116	100.00

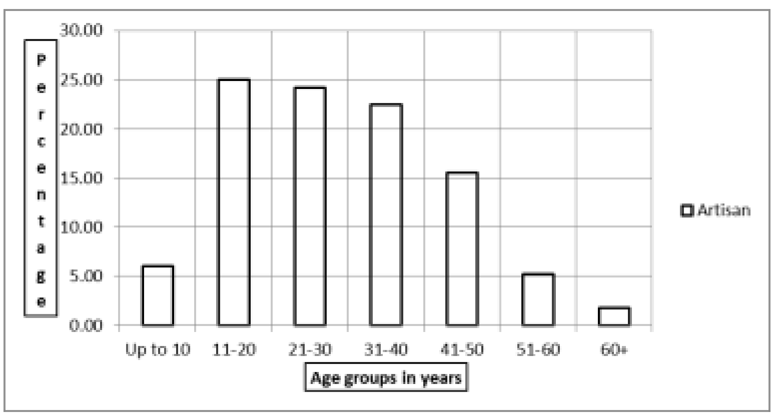


Figure 35.6: Mode of work of artisans of Sadeibereni, Odisha

Table 19.1: Frequency distribution of artisan (male) according to nature of work of Berhampore, W. B.

Age groups in years	Shaping, casting, designing, polishing		Only Polishing		Only Designing		Only Repairing		Total	
	No	%	No	%	No	%	No	%	No	%
Up to 10	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
11-20	5	5.95	1	1.19	0	0.00	1	1.19	7	8.33
21-30	9	10.71	7	8.33	0	0.00	4	4.76	20	23.81
31-40	16	19.05	5	5.95	0	0.00	1	1.19	22	26.19
41-50	12	14.29	1	1.19	0	0.00	3	3.57	16	19.05
51-60	8	9.52	1	1.19	0	0.00	2	2.38	11	13.10
61+	5	5.95	1	1.19	0	0.00	2	2.38	8	9.52
Total	55	65.48	16	19.05	0	0.00	13	15.48	84	100.00

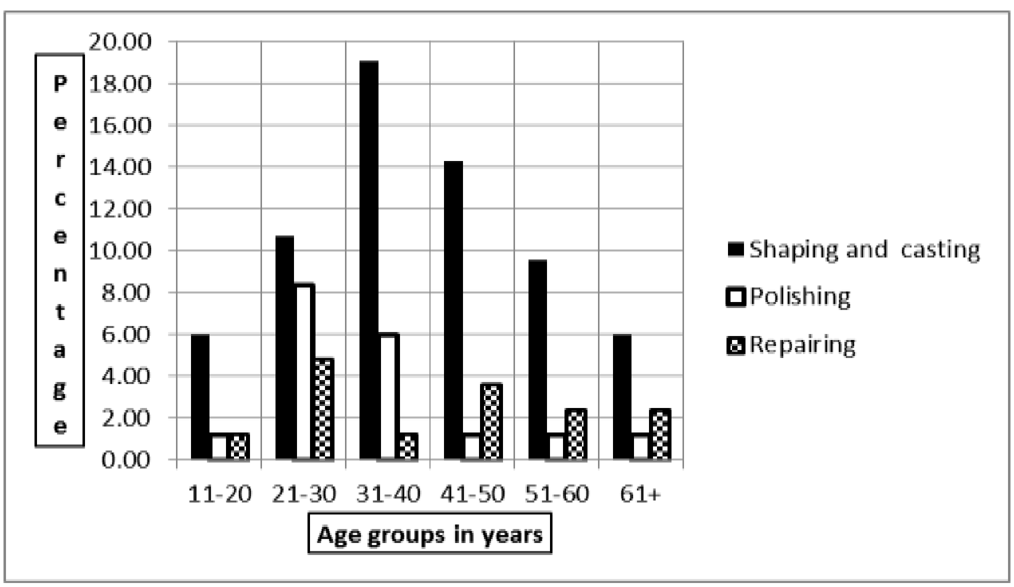


Figure 36.1: Nature of work of artisnas of Berhampore, W.B.

Table 19.2: Frequency distribution of artisan (male) according to nature of work of Shibalaya, West Bengal

Age groups in years	Shaping, casting, designing, polishing		Only Polishing		Only Designing		Only Repairing		Total	
	No	%	No	%	No	%	No	%	No	%
Up to 10	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
11-20	26	6.18	1	0.24	1	0.24	0	0.00	28	6.65
21-30	117	27.79	2	0.48	0	0.00	0	0.00	119	28.27
31-40	106	25.18	0	0.00	1	0.24	0	0.00	107	25.42
41-50	94	22.33	0	0.00	0	0.00	0	0.00	94	22.33
51-60	44	10.45	0	0.00	0	0.00	0	0.00	44	10.45
61+	29	6.89	0	0.00	0	0.00	0	0.00	29	6.89
Total	416	98.81	3	0.71	2	0.48	0	0.00	421	100.00

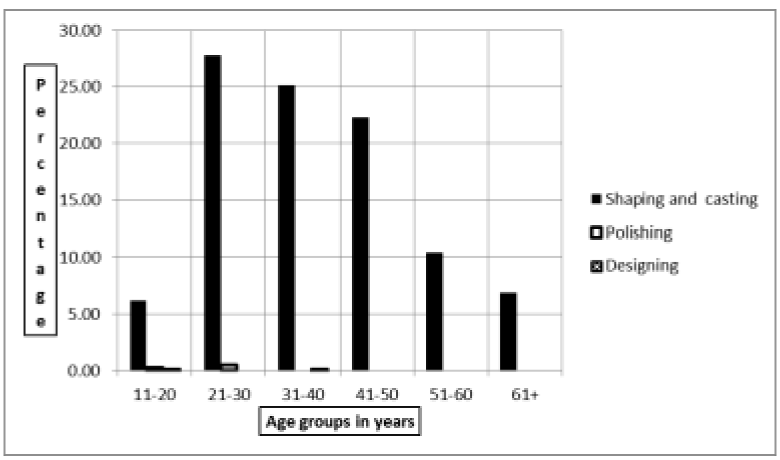


Figure 36.2: Nature of work of artisnas of Shibalaya, W.B.

Table 19.3: Frequency distribution of artisan (male) according to nature of work of Bishnupur, West Bengal

Age groups in years	Shaping, casting, designing, polishing		Only Polishing		Only Designing		Making of moulds		Total	
	No	%	No	%	No	%	No	%	No	%
Up to 10	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
11-20	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
21-30	7	13.46	0	0.00	1	1.92	0	0.00	8	15.38
31-40	13	25.00	2	3.85	0	0.00	2	3.85	17	32.69
41-50	14	26.92	1	1.92	0	0.00	1	1.92	16	30.77
51-60	5	9.62	0	0.00	0	0.00	1	1.92	6	11.54
61+	4	7.69	1	1.92	0	0.00	0	0.00	5	9.62
Total	43	82.69	4	7.69	1	1.92	4	7.69	52	100.00

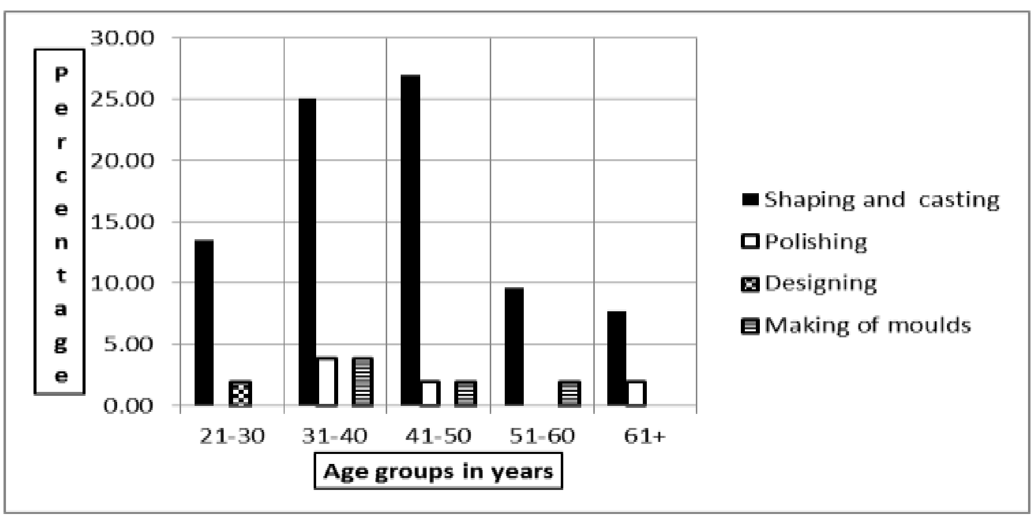


Figure 36.3: Nature of work of artisnas of Bishnupur, W.B.

Table 19.4: Frequency distribution of artisan (male) according to nature of work of Bikna, West Bengal

Age groups in years	Shaping, casting, designing, polishing		Only Repairing		Total	
	No	**%**	**No**	**%**	**No**	**%**
Up to 10	2	2.38	0	0.00	2	2.38
11-20	23	27.38	0	0.00	23	27.38
21-30	33	39.29	0	0.00	33	39.29
31-40	11	13.10	0	0.00	11	13.10
41-50	9	10.71	1	1.19	10	11.90
51-60	5	5.95	0	0.00	5	5.95
Total	83	98.81	1	1.19	84	100.00

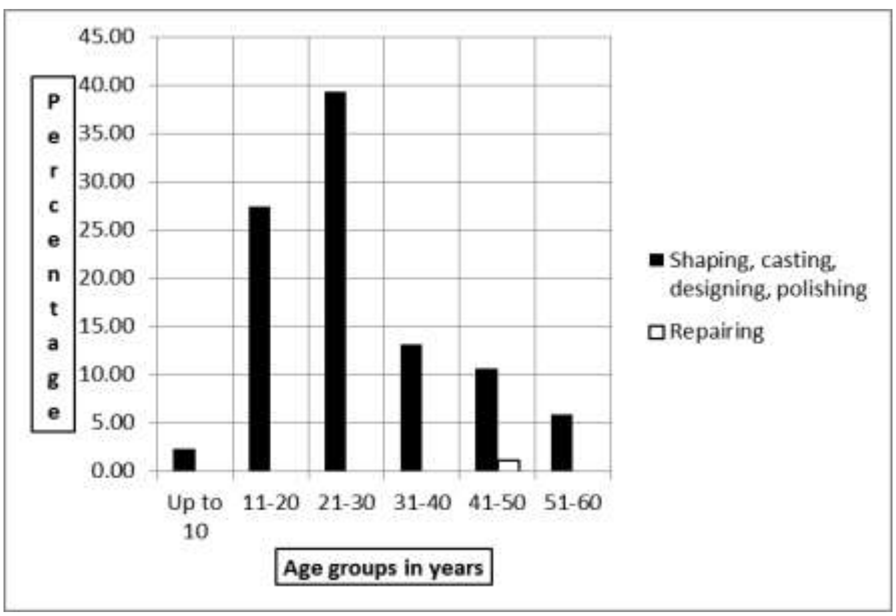


Figure 36.4: Nature of work of artisnas of Bikna, W.B.

Table 19.5 : Frequency distribution of artisan (male) according to nature of work of Rathijemapatna, Odisha

Age groups in years	Shaping and casting, designing, polishing		Only Repairing		Total	
	No	%	No	%	No	%
Up to 10	0	0.00	0	0.00	0	0.00
11-20	30	9.65	0	0.00	30	9.65
21-30	72	23.15	0	0.00	72	23.15
31-40	67	21.54	0	0.00	67	21.54
41-50	64	20.58	0	0.00	64	20.58
51-60	42	13.50	0	0.00	42	13.50
61+	35	11.25	1	0.32	36	11.58
Total	310	99.68	1	0.32	311	100.00

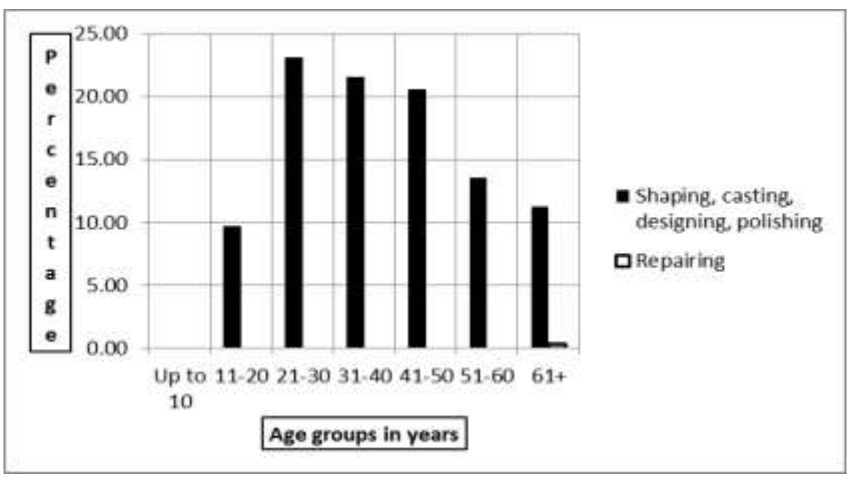


Figure 36.5: Nature of work of artisnas of Rathijemapatna, Odisha

Table 19.6: Frequency distribution of artisan (male) according to nature of work of Sadeibereni, Odisha

Age groups in years	Shaping, casting, designing, polishing		Repairing		Total	
	No	%	No	%	No	%
Up to 10	7	6.03	0	0.00	7	6.03
11-20	29	25.00	0	0.00	29	25.00
21-30	28	24.14	0	0.00	28	24.14
31-40	26	22.41	0	0.00	26	22.41
41-50	18	15.52	0	0.00	18	15.52
51-60	6	5.17	0	0.00	6	5.17
61+	2	1.72	0	0.00	2	1.72
Total	116	100.00	0	0.00	116	100.00

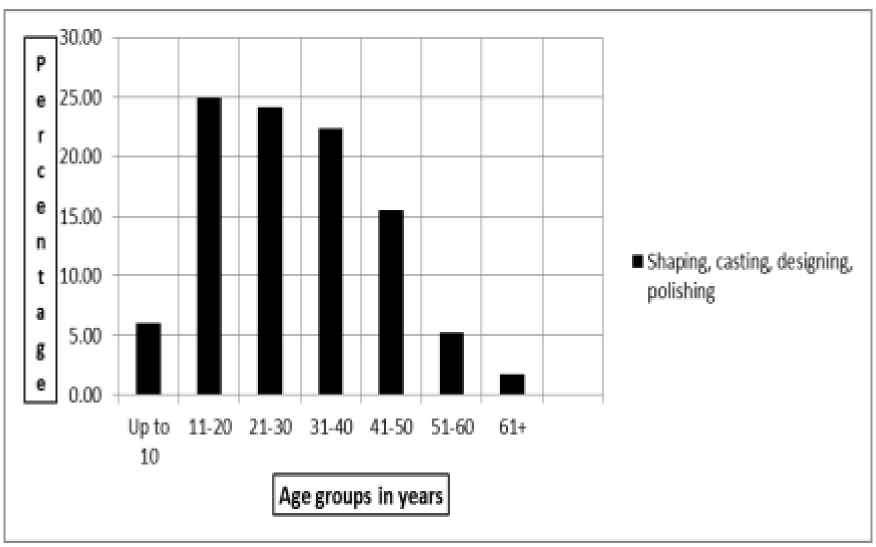


Figure 36.6: Nature of work of artisnas of Sadeibereni, Odisha

Table 20: Involvement of other castes in brass work in the studied clusters

Clusters	Traditional brass working castes		Other castes		Total	
	No.	%	No.	%	No.	%
Berhampore ☆ (Kangsabanik)	70	83.33	14	16.67	84	100.00
Shibalaya ☆ (Kangsabanik)	366	86.94	55	13.06	421	100.00
Bishnupur ☆ (Karmakar)	52	100.00	00	0.00	52	100.00
Bikna ☆ (Dhokra Kamar)	73	93.59	5	6.41	78	100.00
Rathijemapatna ☆ (Kansari)	291	93.57	20	6.43	311	100.00
Sadeibereni ☆ (Ghantara)	105	100.00	00	0.00	105	100.00

(☆ - Traditional caste Groups)

Figure 37: Percentage distribution of the involvement of other castes in brass work in the studied clusters

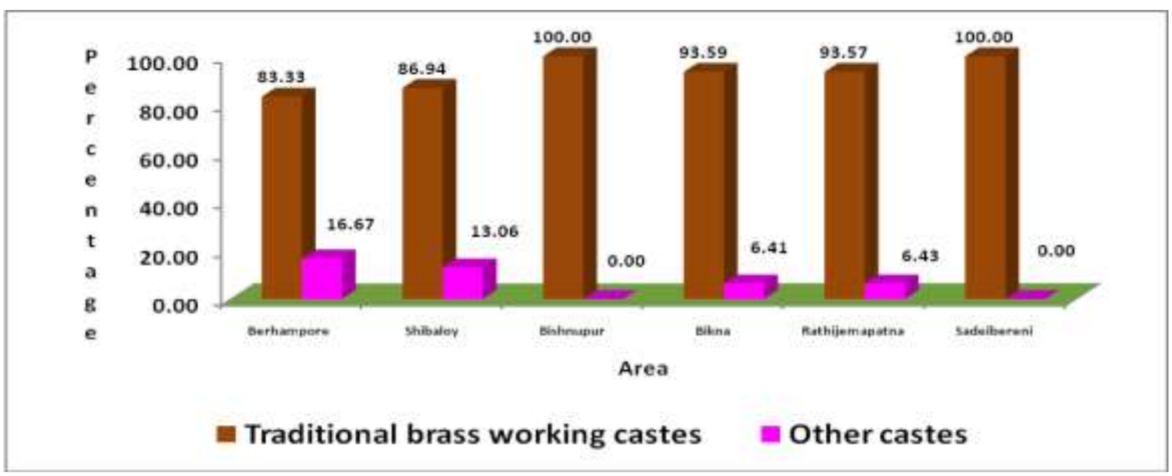


Table 21: Cluster-wise distribution of families on the basis of per capita income

Clusters	Occupation	≤ Rs. 2500		Rs 2501- Rs 5000		≥ Rs 5001		Total	
		No	%	No	%	No	%	No	%
Berhampore, W.B.	Brass work	36	50.00	11	15.28	1	1.39	48	66.67
	Brass work +	1	1.39	4	5.56	0	0.00	5	6.94
	Others	4	5.56	11	15.28	4	5.56	19	26.39
	Total	**41**	**56.94**	**26**	**36.12**	**5**	**6.94**	**72**	**100.00**
Shibalaya, North 24 Parganas W.B.	Brass work	70	22.80	110	35.83	25	8.14	205	66.78
	Brass work +	15	4.89	49	15.96	9	2.93	73	23.78
	Others	7	2.28	13	4.23	9	2.93	29	9.45
	Total	**90**	**29.32**	**174**	**56.68**	**43**	**14.01**	**307**	**100.00**
Bishnupur, W.B.	Brass work	26	20.16	1	0.78	1	0.78	28	21.71
	Brass work +	14	10.85	3	2.33	2	1.55	19	14.73
	Others	54	41.86	25	19.38	3	2.33	82	63.57
	Total	**94**	**72.87**	**29**	**22.48**	**6**	**4.65**	**129**	**100.00**
Bikna , W.B.	Brass work	43	89.58	0	0.00	0	0.00	43	89.58
	Brass work +	5	10.42	0	0.00	0	0.00	5	10.42
	Others	0	0.00	0	0.00	0	0.00	0	0.00
	Total	**48**	**100.00**	**0**	**0.00**	**0**	**0.00**	**48**	**100.00**
Rathijemapatna Odisha	Brass work	106	25.85	25	6.10	2	0.49	133	32.44
	Brass work +	34	8.29	34	8.29	5	1.22	73	17.80
	Others	133	32.44	55	13.41	16	3.90	204	49.76
	Total	**273**	**66.59**	**114**	**27.80**	**23**	**5.61**	**410**	**100.00**
Sadeibereni , Odisha	Brass work	64	77.11	0	0.00	0	0.00	64	77.11
	Brass work +	18	21.69	0	0.00	0	0.00	18	21.69
	Others	1	1.20	0	0.00	0	0.00	1	1.20
	Total	**83**	**100.00**	**0**	**0.00**	**0**	**0.00**	**83**	**100.00**

Table 22: Dependency ratio of population in different clusters

Clusters	Dependency ratio
Berhampore	33.19
Shibalaya	33.82
Bishnupur	30.31
Bikna	71.25
Rathijemapatna	54.77
Sadeibereni	46.80

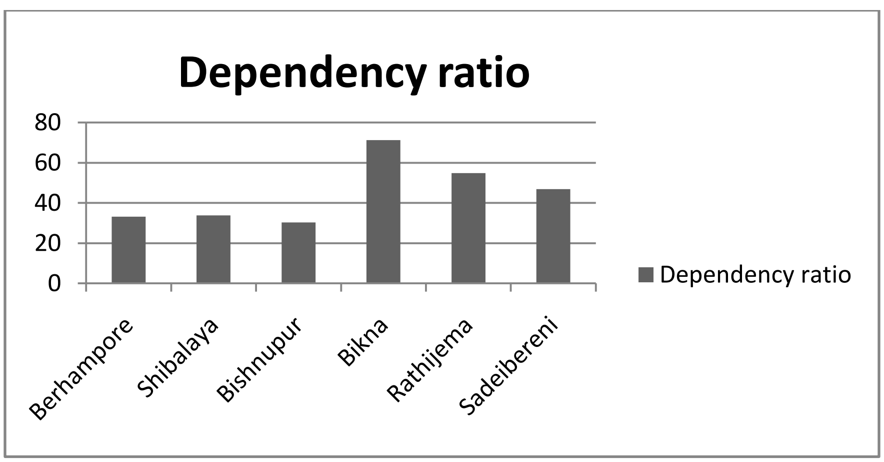


Figure 38: Dependency ratio of population in different clusters

CHAPTER V

5. AN ACCOUNT OF CONTEMPORARY BRASS TECHNOLOGY

Tradition of brass work is still persisting in different parts of eastern India. Emphasis is given on non-industrial mode of technology which is practiced by a number of hereditary groups. For the present study Kangsbanik, Karmakar and Dhokra Kamar from West Bengal, Kansari and Ghantara from Odisha are taken into account. They practice brass work as household craft through generations. Though they belong to different caste groups, but are experts in making different objects from the alloy of brass.

Evidences of technology found in the archaeological context are discussed in earlier chapters. Technological aspects of contemporary brass work, which are practiced by the traditional artisans in different parts of eastern India, are described here with sources of raw material, their processing, technique of shaping and finishing of objects. It may highlight the evolution and migration of technology through the communities from one place to another. Variations of produces as well as technology also are taken into account. Variations are found not only in the techniques, but also in raw materials they used and in the finished products. Skill is also important aspect of the study of craft. Manufacturing of brass objects need special skill and knowledge especially for designing and firing.

Brass workers live mainly in multi-ethnic villages or towns. They serve others with their craft and also depend upon them for subsistence activities. Their economy depends on making and marketing of brass objects. In the present study data have been collected on sources of raw materials and their distance from the area. Tools used in brass working are studied in detail on the basis of their shape, size, material used, cost etc. Firing and Furnace are studied by direct observation method. Each household has its own

furnace. Sometimes families jointly fire their moulds in a common furnace in case of lost wax process. The author observed the process from starting to finish of the objects.

Demand and marketing of brass objects are also taken into account. The artisans were interviewed for information about the process of marketing. Markets are surveyed for understanding the demand and supply. Finally change which is closely related to economy is studied. Change is found in the occupational pattern and also with the material aspects of the craft.

Technology of making brass objects is broadly divided into three types, such as, (i) Wrought metal technique, (ii) Cast metal technique and (iii) Sheet metal technique. In wrought metal technique metal wares are manufactured by beating and shaping and in casting technique melted metal is casted in a mould. These techniques are used to make different kinds of brass objects, sometimes even in combination of the two techniques. Though these techniques are continuing through generations, but changes are noticed in the introduction of new raw materials as well as in the making of new objects, which are in demand.

5.1 Brass technology observed in Berhampore, Murshidabad district, West Bengal:

In Berhampore area two techniques are identified in two sub clusters. At Khagra artisans practice both wrought metal technique and cast metal technique and in Kunjaghata artisans are engaged in making brass pitchers from sheet metal.

5.1.1. Brass technology practiced in sub-cluster Khagra in Berhampore:

At Khagra area brass artisans usually produce brass and bell metal utensils. They also make new objects from old ones, which is locally known as *nolok er kaj*.

a. Raw materials:

Artisans of Khagra area work with various types of alloy, such as, brass (*Pital*) and bell metal (*Kansa*). They also work with an alloy made of copper, zinc and tin with ratio of 4:2:1. Earlier they used to prepare metal alloy with copper, zinc and tin. At present they reuse the alloy. Scrap metals are collected from the nearby Khagra market. Price of scrap brass is Rs. 250/- to Rs. 300/- per Kg. Price of scrap bell metal is Rs. 350/- to Rs. 400/- per Kg. Old and discarded objects are also re used to make new objects after cutting off the damaged portions. Other raw materials necessary for the craft is clay needed for making of moulds. Clay is collected from the bank of the River Bhagirathi. They use both charcoal and cokes as fuels. Price of fuel is Rs. 10/- to Rs. 15/- per Kg.

b. Equipments (Plate-13):

Anvil (*Nehai*): Anvil is made of iron with flat and circular face with 6 inches in diameter. It is inserted into the mud floor with an intermediate wooden block. The height of the anvil from the floor is 6 inches.

Hammer (*Haturi*): There are various types of iron hammer used by the artisans. Each of them has specific function. These are (a) *Gol haturi,* is an iron hammer with rounded end. The head is 4 to 6 inches in length and 1 inch to 2.5 inches in width. (ii) *Gochh*, is another iron hammer with rounded and tapering head measuring 3 inches to 4 inches in length with 0.7 inches width, (iii) *Chouka haturi*, is the hammer with square working end, measuring 4 inches to 5 inches in length and 1.5 inches in width. Length of the wooden shaft varies from 10 inches to 16 inches.

Wooden mallet (*Kather gol haturi*): Wooden mallet is 6 inches in length and 4.5 inches in diameter. This type of hammer is used for raising of flat surface. Length of the wooden shaft is 10 inches.

Stakes (*Shabal*): Different types of iron stakes are used. Iron stake, with one end bent is known locally as *Beki shabal* (8 inches in length). It is used for hammering edges of hollow objects. The stake with a concave top end is known as *Khal Shabal* (4 inches in

length). It is used for making the lower portion concave. Stake with rounded head is known as *Gol Shabal*. It is also 10 inches in length.

Shears (*Katni*): Locally known *Katni*, is a very useful tool designed for the major cutting operation at the time of manufacturing the wares. It is 13 inches long with sharp cutting edge which is 2 inches in length.

Pincers (*Sharasi*): Pincers of various sizes are used. These vary from 10 inches to 20 inches. The artisans make the pincers themselves. Long pincers are used for taking the crucible out of the furnace.

Lathe (*Kunda*): The traditional wooden lathe is locally known as *Kunda*. It is 20 inches in length with spiral curvature at the middle used for moving the lathe by turning with lather strips during scraping.

Iron files (*Ret*): Iron files of different sizes are used for rubbing the edged of the objects. The size ranges from 8 inches to 12 inches with a shaft measuring 4 inches to 6 inches. Width of the file is 0.5 inches.

Chisel (*Panas*): Chisels are used for engraving. Lengths of the chisels vary from 4 inches to 6 inches.

Iron scraper (*Lohalis*): It is made of iron with wooden handle. It is used for scraping. The working end is slightly bent. It is 8 inches long.

Hollow iron frame (*Gar*): It is used for making curvature on the bottom portion of a lamp. It is 5 inches in height and 3 inches in diameter.

Crucible (*Muchi*) and cover (*Dhakni*): It is made of clay and is fired. The size of the crucible varies in length from 5 inches to 12 inches and from 5 to 6 inches in diameter. Thickness is consistently 1 inch. The crucible is supplied from the city of Kolkata to Khagra market. The artisans buy them from local market of Khagra. The cost ranges from Rs. 40/- to 50/-. A disc shaped cover (*Dhakni*), made of clay is used to cover the crucible during firing. It also can preserve the heat created within the crucible. In order to

ventilate smokes produced during melting of metal the cover is perforated with small holes.

Wooden support (*Ghasa kath*): For making this a bifurcated branch of a guava tree is used. It supports the bowl during polishing of its inner portion. A rectangular piece of wood is used for supporting the metal trays at the time of scraping. It is locally known as *Chachhar kath*. It is 12 inches in length and 4.5 inches in breadth. There are screws on the upper surface for supporting the tray. At the time of use it is set on a wooden plank.

Iron rod (*Sarkata*): It consists of a thin iron rod fixed to a wooden handle of 12 inches in Length. The working end is slightly bent. Its use is to separate dregs from molten metal.

Divider (*Chanak*): Circular lines are drawn with this on the plates. This is also used for taking measurements of different designs. It is 11 inches long and made of iron.

Wooden plank (*Chhenda katha*): Sharpening of files and chisels for engraving are done on a long wooden plank.

Mould (*Chhanch*): Moulds of different sizes are used for making different objects. These are made of clay and are rectangular in shape with 3 inches to 5 inches in length and 2 inches to 4 inches in breadth. The width of the mould is 1 inch. Moulds are used for making metal ingots.

Furnace (*Bhati*): Two types of furnace are made. Bigger furnace is made of bricks and clay. This is set in a way that part of the furnace is about 16 inches above the ground and the other part is 18 inches below the ground. Mouth of the furnace is 16 inches in diameter. A 10 inches long air duct connects the underground portion of the furnace at one end. The other end is connected with a hole in the floor in front of the furnace. His type of furnace is used for melting of metals (Plate-36).

Smaller furnace is simple in type. A bamboo of 4 inches diameter and 14 inches in length is driven into the ground leaving a hole in the ground. The end is covered with

clay layer. Another piece of bamboo is driven into the ground to meet the first hole which acts as air duct. This type of furnace is used for heating the objects before hammering.

Blower: Hand operated blow machine is used for fanning the furnace. It is purchased from the Khagra market.

Water tubs: An earthen water pot measuring 20 inches in diameter is fixed on the ground adjacent to the furnace.

c. Workshop (*Sala*):

The workshop of the artisans is situated at a place adjacent to the houses of the artisans. The workshop has three sides open for letting out the smoke produced during hammering and heating of the metal. The workshop is with earthen floor and tiled roof. The furnace is set at the left corner of the one wall. A water pot is fixed next to the furnace separated with mud walls. This is to prevent heating of the pot. The anvil is set just opposite to the furnace. Fire, water and anvil are set in such a way that the artisan can easily access these. The front of the work shed is open. The open space is used for hammering and other activities. Scraping is generally done on the courtyard.

d. Wrought metal technique (Plate 15):

Brass and bell metal objects are produced by hammering of metal ingots. The work is divided into three stages. These are, making of ingots, shaping and finishing of metal products.

Making of ingots

The first stage consists of making of ingots (*Khuti*). At first the furnace is filled with charcoal and fire is set with coal and also with burning coal. The earthen crucible is filled up with scraps of bell-metal. When the flame came out from the furnace the filled up crucible is placed on the furnace and it is covered with a perforated earthen plate.

Air is blown with the blower to control heat. After one hour when it attains the temperature of about 1100^0C the scraps started to melt. It is checked with a stick and dregs are separated with a big spoon. When all the metal scraps melt, the crucible becomes crimson red. It takes two to two and half hours for brass and about four hours for bell metal to melt.

After that the moulds are smeared with oil. Then molten metal is poured into the moulds by holding the crucible with pincers. Size of the moulds varies in respect to the object to be made. The molten metal becomes brownish in colour when it comes in contact with air. Then Paddy husks are spread on it. After cooling the metal ingots are taken out from the mould.

Shaping of objects

The shaping of object is locally known as *garan* and the artisans who perform this are known as *Garandar*. Ingots are slightly flattened by hammering (*Patan kara*). Then a pair of ingots is hammered together. This is done by alternate heating and hammering in three successive stages. The shape is given one at a time. The process is carried out by three persons. The *Garandar* holds the disc on the anvil with long pincers and three hammer men (*Barandar*) hammer by moving it in a circular fashion. In case of making a bowl middle portion of the disc is hammered. This method of hollowing is known as *khala*.

Making of glass is not easy like making a bowl. In case of glass hammering and alternate heating is done for seven times. Each heating is counted as *ak ta* and heating together with hammering is known as *ak balan*. With hammering the flat disc was made narrower, taller and thinner.

The process is very laborious and took seven to eight hours. Sometimes the process continues from early morning till afternoon.

Finishing

Third stage is the finishing which consisted of different sub stages: Scraping (*Chanchha*), Rubbing (*Ghasa*) and Turning (*Konda*). Locally the performers of the work are known are as *Chanchhandar*, *Ghasandar* and *Kundadar* respectively. The scraping of bowl is done by fixing the object against a bifurcated wood with pressure given by the worker with his legs. Scraping is generally done by a long iron scraper which has a wooden handle. Scraping on the outer surface is generally done by fixing it to a traditional lathe, known as *Kunda*. Rubbing is generally done by iron files. One artisan can finish scraping rubbing of five bowls or glasses in a full day. Polishing is done in buffing machine.

e. Making new objects from old (Plate -14)**:**

Another technology used in Khagra for making brass and bell metal objects. In Khgara bigger sized broken plates are used for making smaller plates. New object is made out of the old one. This is locally known as 'Nolok'. They collect old pieces of plates of both brass and bell metal from the market. Sometimes the middlemen also supply them to the artisans. At first the artisans cut off the damaged portion of the plate. Then they draw different designs on these. There are forms of different natural and geometric designs made on hard board. They make relief of designs by alternate heating and hammering. When the shape is completed they temper it with the water. Then scraping is done with the help of iron scrapers. Engraving on the plates is done with chisels. Due to scarcity and high price of raw material and artisans of Khagra adopted this technology.

f. Typology of finished products (Plate -16)**:**

The objects made by the artisans of Berhampore are broadly classified into two types, namely, Household utensils and ritual items.

Household utensils: Brass and bell metal wares include various types of water pots, namely, *Pauli*, *Dilkhus*, *Jaipuri*, *Ghati*; several types of trays, namely, *Alokeshi*,

Monorama, Padma papri, Golappata, Joltaranga, Talsash, Ordhochandra, Angurpata, Calcutta gas, Projapoti; bowls with lids (*Barposh bati)*; glasses with lids (*Braposh glass)* in different designs namely *Gol, Tana, Rasi, Monoranjan and Kalkephul*; spoons; cups and plates.

Ritual items: Different types of plates are used in marriage ceremony. Trays are also engraved with figures of great personalities like Netaji Subhas Chandra Bose, Ramkrishna Paramahansa, Sarada Devi. These are usually for gift to newly married couples. Sometimes names are also engraved on the trays. Hexagonal tray (*Nimak dani*) is used to serve salt at the time of serving lunch to groom. The craftsmen also make lamps (*Prodip*), cymbals, bells as well as other objects needed for ritualistic purposes.

g. Cost of production

Artisans of Khagra do not sell their products directly to the market. Raw materials are supplied by the middlemen and the artisans manufacture various objects. Cost of 1 Kg scrap brass is Rs. 350/-. Labour charges are Rs. 80/-, fuel costs Rs. 15/- and wastage of approximately Rs. 10/- is made. Labour charges for artisans at present ranges from Rs. 65/- to Rs. 75/- excluding the other costs. An artisan can modify 3 Kg to 4 Kg of raw material per day. Market price of bowl ranges from Rs. 250/- to Rs. 350/-, trays of Rs. 500/- to Rs. 2000/-, cup plate set is Rs. 400/- and spoon of Rs. 50/- per piece.

h. Organization of production

Production is a team work involving a number of craftsmen specialized in different types work. There is also division of labour. Master craftsmen (*Garander*), having immense knowledge of metallurgy starting from knowledge about properties of metal, melting points and method of shaping of artifacts, instruct others workers about the technology. Next is the hammer man (*Barander).* He is expert in beating and sits on the right hand side of *Garander*. Other craftsmen involved in scraping (*Chachhander*) and polishing (*Kundander*) sit on the outer side of the workshop. Women are not directly associated with the craft. Males of the age groups 15 to 20 start working in the craft as an apprentice and in due course of time become master craftsmen. Normally working hour is

from 8 am. to 6 pm. with a lunch break in between for one hour. The work hours vary in accordance with the production seasons.

i. Market Survey

The produces of Kharga are exported in different parts of the state as well as to other states. Rates of utensils produced in Khgra are sold in the value of Kgs. These are as follows. cup and plate cost Rs. 350/-, Glass Rs. 1400/-, bowls Rs. 230/- and big trays are sold for Rs. 500/- per Kg. Objects from different areas of West Bengal and also from different parts of the country are sold here. Some of the imported metal objects are, plates from Bansberia of Hoogly, small pitcher of Maldah and Burdwan, spittoon and pellet bells of Ghatal in Midnapore, pellet bells of bell metal, images of god and goddess, big trays and cooking pots from Nabadwip, Plates of Bankura, Betel leaf container and pellet bells of Benaras are sold in different shops of the market as well as light weight materials made in Moradabad are sold here. Products are also sold in different parts of northeast India.

5.1.2 Technology of making brass pitcher in sub-cluster Kunjaghata area in Berhampore:

In Kunjaghata artisans are specialized in making brass pitcher. This is locally known as *Sarba Sundari Ghara*. It resembles to human body which has five parts like mouth, neck, shoulder, belly and bottom. These pitchers look very beautiful with golden glaze. It is generally used in different parts of West Bengal as well as in Bihar and Uttar Pradesh. In West Bengal this type of pitcher is used in Birbhum remarkably in Saithia and Nalhati. It has demand during the marriage seasons. The demand falls down in rainy season.

a. Raw materials:

The pitchers of Kunjaghata are made of brass sheet. Primary raw material necessary for the craft is sheet of brass. Craftsmen of the area generally do not manufacture brass sheet. These are made in Matiari in Nabadwip in Nadia district of West Bengal. Middle men supply disc shaped sheets of varied diameters. These are locally called *Chaki*. Rectangular shaped sheets are also supplied for making the middle portion of the pitchers locally known as *Chadar*. Circular shaped brass sheets of different sizes are used for different parts of the pitcher, such as, shoulder piece and bottom piece. Shoulder and the bottom of the pitcher are made from the circular sheet with a diameter of 12 inches. The belly is made up of a rectangular piece of sheet, 30 inches long and 5 inches wide. Mouth parts are manufactured by casting of brass. The cost of the Brass sheet vary from Rs. 310/- to Rs. 360/-.

Other raw materials are water, coal and borax for soldering. 50 gm of borax is mixed with 75 gm of bell metal grains to make compound for soldering (*Kasapan).* 25 to 30 kg coal is needed to fill up a furnace and the cost is Rs. 250/-.

b. Equipments:

Equipment includes different types of hammers, stakes, hollow wood and furnaces.

Hammer (*Haturi*): There are different types of hammers each with different names and functions. Hammer with rounded head is known as *Gol haturi*. It is 5 inches to 8 inches long fixed to an 8 inches wooden shaft. The diameter of the circular working area is 1 inch. Hammer with square cross section is known as *Chouko haturi*. It is 4 inches long and hafted on 10 inches long wooden handle. The side of the square shaped working area is 1 inch. Hammer with pointed and flat working end is known as *Gochh*. It is 4 inches long hafted to 6 inches long wooden handle.

Stakes (*Shabal*): Different types of stakes are used for the craft. These are not permanently fixed. There are a number of holes on the earthen floors of the factory.

Stakes are used after these are plugged into the hole with a support of wooden block. Artisan can set up the stake according to their position. Stake with a slightly bend at the end with projection is known as *Pati shabal*. It is made of steel and is 30 inches long. Price is Rs 150/-. Stake with long inclined and tapering end is known as *Nauki shabal*. Stakes with special construction is known as *Beki shabal*. It has rounded heads with a bend at both the ends. The upper end is slightly narrower than the lower end. It is 30 inches long. The price is Rs. 800/-. Stake with rounded head is known as *Gol Shabal*. It is 10 inches long and there is a projecting end which is inserted into the ground for fixing it up. Price is Rs. 100/-. These special types of stakes are made by the blacksmith of Simla in North Kolkata.

Shears (*Katni*): It is made of iron looks like pincer. But the working edges are sharp and continuous. It is 12 inches long used to cutting brass sheets as well as extra projections during the fixing of different parts of a pitcher.

Iron rod (*Tipni*): A 6.5 inches long iron rod with pointed end is used for opening of joints.

Pincers (*Sharashi*): Pincers of different sizes are used to hold the parts to be join during soldering. Length varies from 12 inches to 18 inches.

Hollow wood (*Baola*): This tool is long and lower end is buried in the floor. Other free end is roughly circular with a scooped out hollowed surface on top. It is 12 inches in diameter. This is used for making the lower portion of the pitcher hollowed (*Khal deoa*).

Ladles (*Pandani*): This is made of steel and used for application of temper before soldering. It is about 14 inches long tools with a scoop at the working end.

Iron scraper (*Noalis*): It is made of iron with wooden handle. It is used for scraping. The working end is slightly bent. It is 6 to 8 inches long. Very similar to files

Divider (*Chanak*): Iron dividers are used for circular measurements. It is 8 inches long with two adjustable curved legs. The ends of the legs are pointed and meet at a point.

Wooden plank (*Piri*): Different sizes wooden planks are used for seating of artisans. These are of different heights suitable for different types of function. Different sizes of long and flat wooden planks are also used for keeping the metal parts during operation as well as for sharpening of scrapers. Metal pieces are also beaten on these wooden slabs.

Furnace (*Bhati*): Furnace is set underground with a slight projection over the ground. The projection is 8 inches in height. It is bowl shaped and rests on a cylindrical hole. The hole is 12 inches deep and 6 inches in diameter. A clay disc is fixed on the hole which forms the base for the bowl above. Grate of the furnace is made by placing four iron rods on the opening in the centre.

Another type of furnace is used for warming up the upper portion of the pitcher. This furnace is cubical in shape and is raised on the floor. The oven is circular and placed at the middle of the furnace. Hand operated blower machine is used after fitting the oven with the furnace.

Lathe (*Kunda*): The traditional wooden lathe is locally known as *Kunda*. It is 20 inches in length with spiral curvature at the middle used for moving the lathe by turning with lather strips during scraping.

Wooden plank (*Chhenda katha*): A long wooden plank is used for sharpening of files and chisels used for engraving.

c. Workshop:

Workshops are adjacent to their living quaters. Workshops are brick built houses made with tiled roofing. Workshop is not open rather closed from all the sides. As the technology needs minimum heat the craft is being practiced mostly in closed area. They also maintain secrecy from their neighbours about their production. Floor is earthen and sometimes partially cemented. Hammering is not possible on the cemented floors. But polishing is generally done on the cemented floors of the workshop and sometimes under the stairs of their houses. The furnace is set at the corner of the workshop.

d. Process of making brass pitchers (Plate-17)

Process of making brass pitcher in Kunjaghata is divided into two major stages Shaping and Finishing. Different parts of a pitcher are shaped separately. The parts are then joined. Finishing is done after the pitcher is shaped.

Shaping

(a) Formation of the rim (*Mola*)

The first stage of making of bras pitcher is manufacturing of mouth part (*Kana*). This is not practiced in Kunjaghat. But the author observed the process of making the rim in the village Goaljan located on the other side of the river Bhagirathi. This is practiced by another caste called *Jugi*. Clay from the river is mixed with the motor mobile oil. Then the mould, which is made of iron is filled in the clay. Molten brass is poured into the mould. After a certain time gap it is taken out from the mould.

(b) Forming of shoulder (*Gala*)

Second stage is the making of the shoulder. Another disc is taken. At first a circle with a diameter of 3inches is marked from the center of the disc. Then another circle with 11 inches diameter is drawn from the same centre. Lastly another circle is drawn which is ¼" less in diameter than the larger circle.

The innermost circle is cut out from the disc. Then the remaining portion of the disc is hammered on stakes until its edges bend down and gradually form a neck. The diameter of the neck of the mouth piece and the neck of the shoulder piece are matched before they are joined. The necks are filed for perfect fit. Then temper (*Kasapan*) is applied at the joints and heated on the furnace in an inverted position.

The left over pieces are further used for making kerosene oil lamp locally known as *Kupi*.

(c) Making of the middle portion (*Beti*)

Third stage is the making of belly. The rectangular piece of brass sheet is given a cylindrical shape by attaching two ends. The middle portion of the cylinder is shaped to give a rounded shape for the pitcher. The top margin of the belly is matched with the lower edge of the shoulder. Slits are cut in regular intervals around both the edges and joined with each other by heating after applying temper.

(d) Formation of bottom portion (*Tala*)

The bottom surface is shaped in this stage. Another disc is taken for this surface. It is shaped by hammering the sheet on the hollow wooden anvil (*Baola*). The lower most part of the bottom remains flat for resting on the ground. After hammering portions along the edge became half dome shaped. Slits are cut along the edges of both the belly and the bottom. The bottom portion is joined with the belly through the slits. After joining it is again soldered with the application of temper.

After joining all the parts the completed pitcher is hammered all around. These needed 250 to 300 strikes of hammering for achieving perfect shape.

Finishing

Finishing of the pitchers is done by scraping with files. For this purpose the pitcher is fixed to a hand operated lathe. The edges are filed to make it smooth. Now the pitcher is ready for delivery.

e. Cost of production:

Total cost of brass sheets is Rs. 650/- and mouth part is Rs. 300/-. Labour charge is Rs. 150/-. Other costs amount to Rs. 100/-. Total cost becomes Rs. 1200/-. The artisans get the labour charges of Rs. 150/- per piece only. This excludes the other costs, namely, electricity, fuel and soldering materials. The weights of the pitchers made in Kunjaghata ranges from 2 Kg to 2.5 Kg. Market price ranges from Rs. 1000/- to Rs. 1500/-.

f. Organization of production:

Expert artisans have an overall knowledge of the production from start to finish. The artisans who have their own workshop have higher social status. Sometimes they do not engage themselves in the craft directly. They hire labours for production of the objects. The labourers belonging to the Kangsabanik caste group are expert in hammering, whereas labourers from other castes are engaged in joining of the parts. There is a division of labour in making brass pitchers. Newly appointed labours are boys of 11 to 20 years work as apprentices. They take part in hammering the bottom portion and with the application of temper before soldering. They also help in moving the objects from one place to another. Artisans in most of the cases supervise all the works. This is generally done by the family members. Labours contracted from outside took part in soldering the joints of pitchers. Labours are also appointed from the neighbours of the workshop owners. Some are experts only for scraping and polishing of finished products. Each work is completed in two session in the forenoon and afternoon. The forenoon session begins as early as 7 am and continued for six hours. The afternoon session starts at 2 to 3 pm and continues for 3 to 4 hours. The working hour vary seasonally depended on the order and demand.

g. Problems related to the craft in Berhampore:

The workshops are neither well equipped nor cleaned. The work is done in a closed area without proper ventilation. It is also congested with several things. A number of labours and artisans work together in a narrow space. There are no proper toilets and sources of drinking water for the labours. Artisans work in bare feet and do the beating job after heating the metals without any protection for their eyes. Spark coming out of the metal may damage their eyes. Artisans are suffering from regular cough and cold. Breathing problems and arthritis are in common among the artisans. For continuous beating they also suffer from arthritis in fingers locally known as *Jahar bat*.

The primary problem is the scarcity of raw materials. They do not get raw material in proper price from the market. They have to depend on the middlemen for

supply of raw materials. The price of the finished objects is high due to heavy weight. The objects are produced by traditional technology. In spite of these, objects have demand in few areas because of their reselling value.

Attempts have been made by the Government of India for promoting the craft. Different plans and programmes are taken for the development of brass and bell metal industries of Khagra in Murshidabad. These include the formation of co-operative society, training for diversification of products, market generation in the country and abroad, financial support provided by the bankers. Proposal is given for consultation with NABARD (National Bank for Agriculture and Rural Development), DIC (District Industries Centre), Lead Bank Managers.

However some problems still exist. One problem is with the formation of co-operative. The reasons behind the hindrance of forming of co-operative society are identified after discussion with the artisans. These are as follows: (i) selection of group leader for co-operative society, (ii) misconception about the bank loan, (iii) inconsistence behaviour of group members and others. According to their opinion the problems can be minimized by formation of small groups, formation of groups with people who belong to same economic level, formation of groups with those persons who have group cohesion. Artisans also gave their opinion for development of the craft like (i) Formation of bank for raw materials from where they can collect raw materials in proper market price, (ii) training opportunities for making lightweight materials, (iii) marketing of the finished products, (iv) discussion with the artisans to remove their wrong conceptions about the drawing of bank loan, (v) arrangement of some token money during the training for family expenses.

5.2 Sheet metal technology practiced in Shibalaya in North Twenty Four Parganas district in West Bengal:

Artisans of Shibalaya are expert in sheet metal work. They produce varieties of items of brass sheets.

a. Raw material:

Primary raw materials used for the craft is brass sheet. They themselves cannot produce metal sheet. Brass and bell metal sheets are manufactured in Matiari in Nabadwip in Nadia district of West Bengal. They purchase these form dealers of metal sheets. The price of bell metal sheet is Rs. 700/- per kg and brass sheet is Rs. 350/- per kg. Other raw materials used are borax (sohaga), brass powder, bell metal powder, zinc powder. These are for soldering. Price of borax is Rs. 55 /- per kg, brass and zinc powder are Rs. 340/- per kg. For cleaning they need sulfuric and nitric acids. These cost Rs. 15/- and Rs. 22/- per litre respectively. Tamarind leaves, stale rice water, kerosene, mustard oil are also used for cleaning. Sponge bar (Rs. 40/- per piece) are used for bob polishing. Charcoal at the cost of Rs. 18/- to 22/- per kg is used as fuel for furnace.

b. Equipments (Plate- 18)**:**

Various types of instruments are used. Each has specific function, such as, hammering, scraping, polishing etc. These are made of various types of raw materials.

Hammer (*Haturi*): Different types of hammers are used in metal work. These can be classified on the basis of the shape of the working edge, such as, rounded (*Golmatha haturi*), square (*Dalna haturi*), narrow and tapering (*Chauri haturi*). Hammers are made of iron fitted with wooden shaft. Length of the hammers ranges from 8 inches to 16 inches.

Wooden mallet (*Kather haturi*): Wooden hammers are also used. There are two types of wooden hammers, some with square working edge (*Chouri kather haturi*) and others with round working edges (*Gol kather haturi*). Length of the hammer ranges from 8 inches to 14 inches. Head is 12 inches to 14 inches long and thicker than iron hammers.

Circular hollow iron frame (*Chot and Batkhara*): Hollow iron frames are used for giving the requisite shape of the metal wares. Circular frames of different sizes are mainly used to give concave bends to the metal wares to raise circularly and evenly some portions of the metal wares. Frames having flat circular rim are also in common use. These iron

frames are made by the blacksmiths of Simla in North Kolkata. The size varies from 8 inches to 12 inches in diameter, 1 inch to 2 inches width and 2 inches to 6 inches in height.

Anvil (*Nehai*): Anvils are made of iron. It is inserted into the ground through a wooden block. Sizes of the anvils vary from 6 inches to 8 inches in height with diameter of 6 inches to 8 inches. There is also another type of anvil, which has a circular head (*Upor matha nehai*), which is used to make curvature in the inner portion of the objects.

Stakes (*Shabal*): Stakes of different sized and shapes are used. Stakes with straight projecting head is known as *Pati Shabal*. Stakes with bend at the head is known as *Beki Shabal*. The size varies from 10 inches to 12 inches in length. Stakes are manufactured in Shimla in North Kolkata.

Shears (*Katari*): a pair of iron sniper is used for cutting the brass sheets to requisite size. The length varies from 8inches to 18 inches. This is purchased from Duttapukur market and Mmaniktola of Kolkata.

Pincers (*Sharasi*): A pair of pincers is used for holding the objects during heating and hammering. The size varies from 12 inches to 20 inches in length. Craftsmen make these pincers themselves and sometimes get them from local blacksmith.

Spike (*Sola*): Iron spikes of different shapes and sizes are used to adjust the metal ware on the furnace during heating as well as at the time of soldering.

Files: Iron files of different sizes are used for smoothening the rough surfaces and the edges of the metal wares. The size varies from 12 inches to 18 inches in length and width ranges from 0.5 inches to 1 inch. They purchase iron files from local markets at Duttapukur.

Chisel (*Chheni*): chisels are used for carrying out chasing and perforation work on the surface of metal ware. These are commonly 3 inches to 4 inches in length. Shape of the working edges vary from straight, concave and flaring, each with different functions.

Iron scraper (*Nohali*): This is used for scraping of the inner portion of the hollow objects. It is 9.5 inches in length.

Furnace and Blower: Furnace is of simple type resembling those of Berhampore. Hand blower is used for fanning.

c. Workshop (Plate-10)**:**

Workshop is generally adjacent to the houses. The walls are made of bamboo splits and roofs are tiled. Sometimes tin roofing is found. Smokes produced from the metal work can easily be cleared through the gaps of bamboo splits. Floors are always of mud suitable for hammering jobs. Furnace is placed at one corner of the workshop and water container is placed next to the furnace. Hammering carried out on the anvils in front of the furnace. Other works are performed on the open floors.

The traditional structure of workshop is changing rapidly with introduction of new technology. Now they are using bigger machines for molding of the objects in electric operated dice. This machinery need new set up such as continuous supply of electricity. As a result the traditional mud floor is changing to cemented floor because of minimization of beating work by hammering.

d. Process (Plate-18):

The process of making brass pitcher is almost same with the technology used in Kunjaghata in Berhampore. The difference is in mouth parts. In Kunjaghata mouth part is made through casting technology and in Shibaloy is made from brass sheet.

Shaping

(i) Forming of rim ***(Mola)***

At first stage a circular sheet (7 inches in diameter) is taken for making mouth part. It is placed on the iron dice called *Mola* for further shaping. A dome like shape is given by alternate hammering and heating. The innermost circle is cut out to make a hole

in the centre. The hole is 3 inches in diameter. The portions around the cut in the center of the mouth circles are hammered in a stake until its edges bend downward and gradually form a neck.

(iii) Forming of shoulder ***(Gala)***

Then the shoulder part is worked from another circular disc (11 inches diameter). At first the central portion of the disc is cut according to the size of central hole of the mouth. Then it is hammered until it took dome like shape. There is gradual increasing of the diameter from the neck region to belly region. These are hammered all around after setting on a stake.

Then the mouth part is fitted with shoulder part. Before joining the edges of necks are filed. Narrow slits are cut around the edges and after fitting with shoulder part the joints are soldered with temper. Then this part is again hammered.

(iv) Forming of middle portion ***(Beti)***

Belly portion is made from a rectangular piece of brass sheet measuring 27 inches long and 5 inches wide. It is made into a cylinder by hammering. The shape is given in such a way that the outer circumference matches with the lower margin of shoulder part. Then the edges are joined after cutting finger slits at the edges. This part is hammered after setting on a stake.

(v) Forming of bottom portion ***(Tola)***

The bottom portion is made from a circular disc measuring 11 inches in diameter. The circle is shaped by hammering on hollow iron block adjusting with the lower edges of the shoulder. These portions are joined by cutting the slits. Then it is hammered all around by iron hammers for final shape.

Finishing

The irregular edges are filed and the pitchers are scraped in a lathe. At last this is polished in buffing machine.

e. Making other objects from metal sheets:

Different types of objects are made from sheet metal. Metal wares are given the desired shape by beating the sheet metal in to the required shape. At first sheets are cut according to the desired sizes. Then beating is done with wooden mallets and iron hammers over iron stakes and iron block. The metal sheet for making round tray is first levelled in flat anvil. The required size is etched with an iron compass. Then they cut it as per the required size and shape with iron snipers. Metal sheets are annealed in open furnace for raising the edges. They hold the tray with pincers in right hand and with the left hand operates mechanical bellow. Raising of the edges are done by beating and pulling the rim upwards. Then the trays are smoothened with files and washed with sulphuric acids and then polished. At present these are moulded in electric operated dice. The cost of the machine is Rs. 50,000/- and above.

f. Typology of finished products

Household utensils are mainly produced in Shibaloy. The products include three types of pitchers (*Deshi kolsi*, *Kagmari kolsi* and *Ghara*), small pitcher, handi, bowl and big bowl (*Gamla*).

g. Cost of production

Brass sheet of 2 Kg is needed for making a pitcher. Price is of Rs. 800/-. Labour charge is Rs 50/-. Other costs are Rs. 10/- for acid wash, Rs. 10/- for welding. There is also wastage amounting to Rs. 10/-. So total cost of production is Rs 880/- to Rs. 900/-. They can sell a pitcher with profit of Rs. 80/- to Rs. 90/-. Market price ranges from Rs. 1000/- to Rs. 1500/-.

h. Problems related to the craft:

Most of the workshops are made of walls of bamboo splits and are congested. Labours do not have proper toilet facilities. They also work with bare eyes and feet. It may produce blisters. Artisans are also suffering from arthritis and breathing problem.

Other problems are shortage of raw material. Supply of raw material is insufficient according to the demand. In most of the cases they have to depend on dealers, traders and middle men for supply of raw material. The products have no demand outside the states. Low capital and less awareness of new technology are also the hindrance of continuation of the craft.

i. Market Survey:

Nearby market is adjacent to Duttapukur Railway station. Products from different areas are sold here. These are glass, bucket, different types of trays (*Noth thala, Bogi thala, Mihi thala, Porat*); betel-leaf container (*pan bata*), Winnowing fan (*Kula*), Spittoon (*Pikdani*) and ritual objects like flower basket (*Pushpa patra*), lamp (*Jol pradip*), cymbals (*Kortal*), flower dish (*Puspopatra*), incense burner (*Dhupdani, Dhunuchi*), bell (*Kansar*), Sandal wood container (*Chandan bati*), betel leaf (*Pan pata*). Most of these items are of low weight material and are made in Muradabad. They buy in retail price from Burra bazaar in Kolkata.

5.3 Brass work in Bishnupur in Bankura district of West Bengal:

In Bishnupur artisans are concentrated in two areas of Kaity Para and Kamar Para. Brass utensils are manufactured by casting technique. There is no tradition of Bell metal work in Bishnupur. Artisans are familiar with brass and German silver (an alloy of copper, zinc and nickel in the ratio of 4:4:1). As the technique is primarily casting they did not adopt the technology of wrought metal.

5.3.1 Casting technique of making brass pitcher in the sub-cluster Kamar Para in Motukganj:

In Kamar Para the artisans are expert in making of brass pitchers. These pitchers are made by casting technology.

a. Raw materials:

Primary raw material used for making pitcher are two types, such as, alloy of copper and zinc (*Pital*), alloy of copper, zinc and tin (*Bharan*). At present they use the scrap metals which are supplied by middleman as well as shopkeepers of nearby market.

There is elaborate process of making mould before casting. Moulds are made from locally available clay. They collect four types of clay, namely, red soil (*Lal mati*), sandy soil (*Sada mati*), sticky red soil (*Chitta mati*) and alluvium soil (*Antel mati*). Red sticky soil and sandy soil are collected from the jungle area near Lalbandh. It is about 3 km from the area. There is a deposition of reddish silt. Sticky red soil (*Chitta mati*) is collected from the area of Jamunabandh 2.5 km away from the area. Sticky fine alluvium soil is collected from Mundamala Ghat from the bank of the river Birai. It is about 2 km away from the area. These are brought by bullock cart. Price is Rs. 80/- per quintal. Clay is mixed with Jute fibers to prepare the dough, from which molds are made. Jute fibers can bind the clay more strongly and keeps the structure intact also in wet condition. 25 kg of clay is required for making four parts of the mould. 100-150 grams of jute fiber is mixed with 25 kg clay.

To make a pitcher of 4 Kg weight 5.5 Kg scrap metal is needed. Other ingredients necessary for the craft are mustard oil for smearing on the moulds and coal for fuel. 12 kg of coal is used for casting one pitcher.

b. Equipments:

Equipments are called *Hetar*. A number of equipment are mostly needed for finishing of the work after casting. These are iron anvil (*Nehai*) which is 8 inches long

and 6 inches in diameter used for sharpening iron tools; iron saw (*Chanar*) is 6 inches long and 5inches in breadth is used to measure the distance to be joined; iron stake (*Shabal*) with curved and rounded working end is used for fixing the inner portion of a pitcher during hammering; iron hammer with square shaped working edge is used for beating and shaping; and iron scrapers (*Huga*) with 8inches to 12 inches in length, fixed on wooden shaft are used for scraping of the outer surface the pitcher and a number of iron files are used for smoothening the surface. Long pincers made of iron are used for holding the mould at the time of taking it out from the furnace. A wooden mallet (*Muguri*) is used, which is made of wood from *Sal* tree. Beside these a number of electrically operated machines are used, such as, welding machine, blower and lathe.

Furnace is 3 ft high from the floor level. The surface of the top is rectangular (5 ft x 2.5 ft). There are two ovens side by side, each with 18 inches diameter. Two outlets are at the bottom of the furnace. Furnace is made of bricks and clay.

c. **Workshop** (Plate-11)**:**

Ground plan of the workshop is rectangular. Walls are made of bricks and roof is tiled. Furnace is set attached with one wall and the rest area is mud floor used for performing functions like making of crucible, casting and finishing of the pitchers. Moulds are generally made on the courtyard by women folk of the community.

d. Process (Plate- 19)**:**

The process is broadly classified into three stages such as making of mould, casting and finishing.

Making of mould

Making of mould is an elaborate process. It is locally known as *Chhada para*. There are sub-stages of making of mould. Two moulds are made one for upper part of the pitcher (*Chhada)* and another for lower part (*Khupri*). The mould for upper part has two parts such as body and the mouth (opening of the pitcher). The body part is divided into

two; upper part and lower part. These two parts are made separately and joined together after drying. The inner and outer moulds are locally called *Bhitor khol* and *Matha khol*.

(i) Mould for lower part: At first the master dice made of brass is smeared with automobile engine oil. Then clay is put on the inner surface of the brass mould and pressed with fingers up to 0.5 inches thickness. Then the mould is put in an inverted position on an iron frying pan (*Tawa*). The pan is moved anticlockwise and clay is smeared clockwise. Then clay is put on the outer surface of the mould and pressed with fingers to make the 0.5 inches thick outer diameter. Then the clay is put on the base and leveled. The edges of the outer layers are turned and joined with the inside layer.

Then the mould is turned up-right. The inner and outer layers are pushed up and separated from the brass mould. Then inner layer is turned outside and joined with the outer layer. Extra clay is put on the base and kept near the furnace for drying.

(ii) Mould for upper part: Clay is put on the inner surface of master dice and then pressed with fingers to make a layer of 0.5 inches thickness. Then it is placed upright on an iron frying pan. The outer surface of the master dice is covered with 0.5 inches thick layer of clay. Then the mould is kept at the side of the furnace for firing.

(iii) Mould for opening of the mouth: After drying of the mould, clay is put on the upper part on the outer and inner part of the mouth. Two vents are created at the mouth for entrance of the molten metal. Then it is kept near the furnace for drying.

(iv) Opening of moulds: When the moulds are dried then it is separated from the master dice. A groove is made at the bottom to make foot of the pitcher with a divider. At the bottom a vent is cut with the help of hexa blade. Brand names of initial of the artisans are engraved at the bottom.

Finishing of mould

Finishing of mould is called *Chhanch sara*. Rubbing and polishing is done by sand papers and also with wooden splits. Finally the moulds are polished with wet cotton

cloths dipped into semi liquid mixture of alluvium clay. Inner portions of the moulds are being smoothened as much as possible to minimize finishing work after casting.

Once the moulds are ready other parts like outer and inner layers of upper, lower and mouth parts are joined with coating of clay. Making of mould is the crucial part of the technology. It takes two to three days for final finishing. It is very labourious. As a result progress in production is limited. Much concentration on the part of the artisan is necessary for the making of mould, otherwise total manufacture will be damaged.

Making of crucible (Muchi)

Crucibles are made with clay. At first a cone shaped crucible is made, which is 6 inches in length. After that it is dried. Then the length of the crucible increased up to 12 inches by application of extra clay. Paddy husk is applied on the out surface for retention of heat and to prevent damage. Then another coat of alluvium clay is added and kept on a clay rim for drying. A crucible may be used for two times for casting.

Then crucible is filled up with brass scraps. For lower portion of the object 2 kg. Brass scrap and for the upper portion 3 kg brass scraps are used. Small quantity of salt is mixed with the brass.

Fixing of mould with crucible (Ghura Chhach)

Mouth of the upper mould and upper edge of the lower mould are covered with clay for fixing with crucible. Then it is fixed with the crucible in an inverted position and joined with layers of clay. It is again covered layers of clay and paddy husk is applied on it. Then the upper mould is fixed with another crucible and joined with layers of clay.

Casting

The furnace is covered with coal and charged with firewood and the crucibles are placed keeping the lower part of the crucible at the bottom. Artisans can understand from the colour of the crucible and also based on time whether the metal melted or not. After three hours the mould is taken out from the furnace holding with pincers. For some times

it is kept in an upright position and then it is turned over to transfer the molten metal into the gaps of the moulds.

Finishing

Finishing include Filing, Welding, Scraping, engraving and Polishing. Black carbon deposited is removed by files. After that the surfaces are ground in machine operated stone grinder. The edges are smoothened with files. Then both the upper and lower parts are joined together by welding in gas welding machine. After welding the joint area is hammered. After that the whole body of the object is smoothened with files. Scraping is known as *Chhilai*. Scraping is done after fixing the pitcher with the lathe. A mixture of resin and brick powder is used for this. Grooves are etched on the outer surface of the pitcher, locally known as *Matha deoa*. In case of pitchers made from German silver scraping will be done on entire outer surface and in case of brass pitcher scraping is done only on the upper portion.

Various types of designs are engraved on the upper part of the pitcher. Natural motifs like flowers, leaves, twigs, creepers, peacocks are engraved. Motifs of historical significance such as famous terracotta temples, Jor Bangla and the famous canon, Dalmadal Kaman are etched on the surface. These have demand on occasion of marriage.

e. Cost of production

To make a pitcher of 4 kg an amount of 5.5 kg of scrap brass is needed. Cost of the pitcher is Rs. 1400/-. Labour charge is Rs. 100/-, fuel is Rs. 60/-, and wastage Rs. 150/-. Their profit excluding the other cost is Rs. 320/- per pitcher. Average height of the pitcher is 1 ft. Market price of pitchers ranges from Rs. 2500/- to Rs. 3000/-.

5.3.2 Technology of making brass objects in the sub-cluster in Kaity Para in Krishnaganj, Bishnupur:

Artisans of Kaity Para are experts in making glasses of different types and small pitchers (*Ghoti*). They are using the cast metal technique for making glass and small pitchers. They are familiar with brass, German silver and *Bharan* (alloy of copper, tin and zinc).

a. Raw materials:

Artisans use three types of alloy such as brass (proportion of copper and zinc is 1:1), German silver (proportion of copper, zinc and nickel is 4:4:1) and bell metal (*Bharan*) with proportion of copper, zinc and scrap bell metal is 5:4:1). At present they are using scrap metal. Huge quantity of clay is used for making of moulds. Three types of clay are used for making of moulds such as sticky red soil, sandy soil, and sticky fine soil. These soils are collected from Maynapukur within the 3 km periphery of their habitats. The price of scrap German silver is Rs 250/- to Rs. 300/- per Kg. rate of new German silver is Rs. 350/- to Rs. 400/- per Kg. Coke and charcoal are used as fuel for furnace. Rate is Rs. 10/- per Kg.

b. Equipments:

Different types of equipment are necessary for making glass and small pitchers. These are iron pincers (*Sharasi*) 22 inches in length, iron stakes (*Shabal*) 15 inches in length, small wooden stick (*Golla kathi*), iron needle for applying soldering material (*Pan khori*) which is 15 inches long, wooden mallet is 11 inches long with rectangular working edge (3 x2 inches). Spoon like instrument (*Bauli*) is 8 inches long. Pincers and iron rod with hook are also used.

Furnace is of two types. They are identical but shapes are different for the purpose of adjustment with the vessels of different shape. The furnace in which moulds of small pitchers and glasses are fired is 6 ft to 7ft high from the floor. The upper surface is circular with a diameter of 40 inches with hole of 20 inches in diameter. Lower portion of

the furnace is embedded 3 ft. underground. Fourteen pieces of mould can be heated at a time in this type of furnace. Smaller furnace is used for smaller jobs.

c. Process (Plate- 20)**:**

Process of making glass and small pitcher are divided into four stages which is locally called *Ara*. The first stage is making of mould (*Chhanch*). Second stage is the finishing of mould. Third stage is casting of mould and fourth stage is finishing and polishing.

Making of moulds

Clay is processed at first for making of moulds. Three types of soil are ground and sieved. After kneading with water it becomes sticky. Sand and jute are also mixed with the clay, which acts as tempering material.

The dice of a glass is smeared with mustard oil. The outer wall of the glass is covered with clay, already prepared. The clay coat is cut vertically into two halves. This is known as *Chanak kara.* Then the bottom of the glass is smeared with oil and coated with clay. When these parts of the mould became leather hard the moulds are removed with gentle strokes given with an iron rod. These three parts are put together and tied with a string.

For the next step cow dung is mixed with water and sieved. Then it is mixed with the prepared clay for making the core of the mould. Inner portion of the dice is filled up with this clay and pressed with a wooden rod to fit the clay on the lower part of the mould. The filling is done up to 1 inch below the upper edges. This is locally known as *Chhanch kunda dewa.*

In the next step clay is pressed on the top edges of the core. This is locally called *Kana chaki dewa.* When the moulds became dry the parts are separated with the rod. So the moulds have four parts; core, bottom (*Chaki*) and two side parts (*Pati*). After drying the mould is beaten with iron rod and the parts are separated.

After making and drying of the mould *Sarandars* clean and scrape the mould. A thin space is left between the core and inner portion of the outer mould. After scraping a coat is given on the outer surface with a paste of cow dung mixed with water and clay. After drying these parts are polished with stone pebbles. A little lump of wax is fixed on the bottom of the core.

The mould is insulated with final coat of clay, which is applied to the whole body of the mould. A slit is cut at the bottom for runways of molten metal. The crucible which is locally made is joined with the mould and a small hole is made for letting out gases of molten metal.

Casting

Casting is done on the furnace. After charging with fire wood and coal the furnace is covered with pieces of earthenware and moulds are arranged on top. It takes 2 hours 30 minutes to 3 hours for melting of metal at about 1100^{0} C. 30 kg of coal is needed for one time casting of 14 moulds.

Finishing

After casting moulds are taken out from the furnace and cooled down. After cooling the moulds are broken and the glasses are taken out. The glasses are files and scraping is done in hand operated lathe and are polished both in the inner and outer sides. Grooves and different designs are engraved along the edge of the glasses.

d. Finished products:

The artisans of Bishnupur are expert in making household utensils like diverse types of small pitchers (*Ghati*), namely *Patnai Lota, Gayaswari, Pauri, Geni pauri, Balarami, Kashiali, Nepali, Hambu, Ghat, Ghoti;* Glasses namely *Bhatial, Mynapur, Bonde Gelas, Gina, Pol, Renu, Khejur Chhari;* bowls like *Monoranjan* and feeding spoon *(Jhinuk).* Each utensil has specific functions, such as, measuring of milk, storing oil. They also made a small ladle for taking out oil from the pot and also to prevent wastage.

In tribal societies special types of small water pots are used for carrying oil to their bath. These pots also have ritual use such as offering of milk and water to lord Shiva. Such pots are supplied to the tribal groups inhabiting in different parts of the districts. They also make utensils in accordance with the preference of the tribal groups.

The above mentioned items also have demand for rituals performed in our daily life, such as, in Marriage, first rice giving ceremony (*Annaprasan*), ceremony for giving desired food to pregnant women (*Sadh*), post funeral ceremony (*Sradhha*) etc. Earlier 16 different items were gifted from the side of bride’s to the bride as trousseau. At present the numbers of the items have come down because of high price of the objects.

e. Cost of production:

Quantity of Brass or German silver needed for casting of a glass is 700 gm. Price for it is Rs. 250/-. Labour charge is Rs. 10 and fuel is Rs. 8/-. Their profit excluding the other costs varies between Rs. 20/- to Rs. 30/- per piece. Market price of small pitchers (height of 3.5 inches to 4 inches) ranges from Rs. 150/- to Rs. 300/- and glasses of Rs. 250/- to Rs. 350/-.

f. Organization of production:

The technique is mostly based on casting. So making of mould is an elaborate process which is done by the women of the families. Casting is done by middle aged male members. Crucible is made by people belonging to lower caste group, like Kolu and Bauri and firing is done by other caste groups. Young men of 16 to 20 years of age work as apprentice. Reason for sustenance of the craft are; firstly, for the demand in the market and secondly there are a number of communities involved at different types work, such as, collection of clay, preparation and scraping of mould, and heating of furnace. Artisans also serve the other communities living in the area.

g. Problems related to the craft:

The working environment is not good. Safety of the artisans is less. They handle the hot crucible at high temperature with their bare hands also do not take any precaution from the spark coming out from the crucible. Arthritis is common problems for the artisans. It is also difficult to work in summer seasons.

A number of problems are identified relating to the craft. Such as no formally registered association for functioning of the enterprise, craft is fully dependent upon traders. They follow traditional technology which is labor intensive, time taking and has very low productivity. Raw materials used are of poor quality. Market is limited due limited products with focus on rural markets. Heavy weight of the products, outdated designs, no product diversification and lack of brand image further hinders sustenance of the industry. There are no dealers networks for marketing except for local middlemen. Traditional furnace and moulds are used with high depreciation value.

h. Market Survey:

Retail market of brass wares is Madhabganj, which is situated near to the settlements of artisans. Brass items made in Bishnupur are sold in Madhya Pradesh, Odisha and several other districts of West Bengal including Midnapore, Bankura and Kolkata. A survey was done on brass and bell metal shops of Bishnupur. It has been observed that brass products made at different parts of the district are sold here as the place is famous as trade centre as well as tourist spot. Bell metal objects made in Ajodhya, Laksmisagar in Bankura, lamps in Patrasayar, cooking vessels made of brass sheet in Matiari, Nadia district are sold here. Flower vase and images of God and Goddess made in Ganjam district of Odisha are also sold here. These items have demand in the season of marriage for both caste groups and tribal groups.

5.4 Lost wax process of brass casting practiced in Bikna, Bankura district of West Bengal:

In Bikna of Bankura district of West Bengal, artisans belong to the caste Dhokra Kamar, who are experts in lost wax process of brass casting (*Cire perdue* technique). Different types of raw materials and equipment are used for different steps from building of core to final finishing.

a. Raw materials:

Primary raw material necessary for the craft is brass. At present they use scrap metals. Price of brass scrap is Rs. 350/- Kg. They do not select the scraps randomly rather they try to separate brass with ratio of copper and zinc 6:4 with their immense knowledge of the property of metals and alloying. So if there are more impurities they substitute it with adding the extra metal and make them proportionate. Metals are broken into small pieces suitable for crucible of different sizes.

For building of core they use several types of clay such as clayey soil (*Chita mati*) and sandy soil (*Neyna mati*). Clayey soil is collected from the river bank and brought to the village in bullock carts. The cost is Rs. 60/- per quintal. Sandy soil is collected from the land around their village. The soil is collected from about 6 to 12 inches beneath the soil. Soil is used after sieving out the grits. Cow dung is mixed with the soil to make it sticky.

Wax is used for making patterns on core, which is made of clay. Wax core instead of clay core is used for solid casting. Two types of wax are used such as bees wax and paraffin wax. Price of bees wax is Rs. 100/- to Rs. 150/- per Kg. Cost of paraffin wax is Rs 80/- per Kg. Due to scarcity of wax they are using resin mixed with pitch and mustard oil. Price of resin varies from Rs. 80/- to Rs. 120/ per kg. Price of pitch is Rs 45/per 5o Kg tin.

Coal is used for fuel. Price of coal (*Kath koyla*) is Rs. 300/- to Rs. 400 per quintal. Coal which is produced from burning wood is supplied from cremation ground. Price is

Rs. 50/- per kg supplied by people belong to the caste group Bagdi. There is a belief that the work could not be completed without charcoal collected from cremation ground.

At present they are using enamel paints for giving the product a gorgeous look. The price is Rs. 70/- per 250 gram tin.

b. Equipments:

Equipment is of simple type and operated with fingers. They use iron nails (*Ketni*) for cutting wax threads. Length varies from 5 inches to 6 inches. A small iron needle (2 inches long) is used, which is locally known as *Tipna*. It is used for cleaning burnt clay from the model. A number of wooden pens are used for drawing designs by impressing over the model with them. These are locally known as *Hetar*. These are not straight rather bent at the middle made from the stems of chrysanthemum plants. Length varies from 3 inches to 5 inches. Iron chisels (*Chheni*) with 4.5 inches length is used for smoothening of rough surfaces. Iron hammer is used for breaking of coal, metals and fired crucibles. Beside these iron tongs of different lengths are used for holding the red hot burning crucible and for taking them out from the Furnace. Balance is also used for weighing of brass scraps to be filled in the crucibles as well as weighing the finished produces.

There are common Furnaces for the community. These Furnaces are made on a raised mud floor facing the direction of wind. Furnaces are semicircular in shape measuring 10 inches to 15 inches of height. These are made of bricks and mud.

c. Process (Plate- 23)

Technique of lost wax process in Bikna is divided into a number of stages which are again divided into sub stages.

Predesigning Stage

(i) Building of core

Core is built with clay in case of hollow casting and in solid casting it is made of wax. Clayey soil is mixed with sand in 2:1 proportion for making of cores. It is kneaded with water to the consistency suitable for making models. After drying in sun the surface is smoothened with coating of clay paste. In case of bigger objects models of different parts are made separately. They keep these models on a flat wooden plank for drying in the sun. They make models of different sizes with hand. It is also interesting to note that they do not use any dice. However they can produce large number of objects having same size and with similar motifs depending on their eye estimation.

(ii) Preparation of wax

Wax is mixed with tree resin and mustard oil which is used for making of designs. Resin is an extraction of the tree of *Shorea robusta* (*Sal*). They purchase it from the market. It is broken into small pieces. Wax, resin and mustard oil are mixed in the proportion of 2:3:5 and heated on an oven for one hour. In scarcity and for high price of wax they also use bitumen after mixing with resin and mustard oil. When resin melts it mixes with wax and mustard oil and forms a black compound. Then it is sieved in a cloth which is poured into a vessel of cold water. After some time it becomes hard. They can use this wax as per the requirements.

Designing and covering stage

(iii) Wax designing around the core

Resin-wax of required quantities is then heated on mild fire of wood. The wax becomes rubbery and can be extended in to desired thickness and diameter. They have their own mode of measurement in terms of threads, like *solo suta* (sixteen threads), *at suta* (eight threads), *du suta* (two threads), *ak suta* (one thread). At first mould is wrapped with flat wax thread measuring 1.5 inches in breadth. This process is called *Lebrano*. After covering they make design on it with narrow threads and cut with the nails of thumb and index finger. There are different designs of wax threads such as *tikra* (triangle), *jhilpi* (spiral), *jhinga bichi* (seeds), *ball* (circle), *chonger bhanga* (half circle).

(iv) Building of wax channel

Channels made of wax thread are fixed with the mould at the highest point of the mould to make freeway for molten metal.

(v) Covering of mould

A clay blend is prepared with mixing of sandy soil and cow dung with water. Designed moulds are then dipped into this clay blend for few seconds and dried. This is locally called *Gadgad*. After that moulds are covered with second coating of clay. This type of clay is prepared by mixing of clayey soil and sandy soil kneaded with required amount of water to make it sticky. This is locally called *Dheorano mati*. After drying two or four moulds are joined together with clay. This process is locally called *Juro*.

Precasting stage

(i) Making of crucible

Crucibles (*Chong*) are made from clayey soil. It is cylinder shaped and hollow with flaring mouth. Crucible is fixed on the highest point of the mould around the wax runners. The thickness of the crucible is $1/4^{th}$ inch and made of clayey soil. Then the whole thing is dried in the sun.

(ii) Filling with brass scraps

After drying crucibles are filled with brass scraps. The quantity of wax is the indicator of brass needed for the craft. Usually brass is taken about ten times of wax in the design. Brass scraps are weighed in balance and put inside. The crucible is then covered with clay cap (*Mutno)* and dried. Now it is ready for casting.

Casting stage

Firing is done after arranging firewood, cow dung cake and steam coal inside the Furnace and then fuel is charged with fire. The moulds are arranged in the Furnace in an upright position. After two hours the temperature attains at 1100^0C and metal started to

melt. Metal smokes vent out from the openings of the crucible. Whether the melting is complete can be identified from the colour of the flame, which gives out a greenish yellow glow. They bring out the crucibles from the Furnace with the help of a pair of tong and shake it gently. They hold the crucible in upright position so that the molten metal can flow from the crucible through the wax channels and cover the inner gaps produced by the evaporation of wax. Total process of casting takes about two and half to three hours.

The mould is cooled by sprinkling water on it. It is broken by hitting with iron rods and the metal model comes out.

Finishing

The extended part of metal channel is cut from the model. Then cleaned with hard brush and sometimes filed for smoothening. Recently they are using golden metallic colour for getting a gorgeous look.

d. Finished products (Plate-24):

Finished products are divided into three types according to the function of the objects.

Religious items: Image of God and Goddess (*Laxmi, Narayan, Ganesh, Saraswati*, *Durga, Radha, Krishna, owl, laxmi set*); incense burner, lamp set, bell for worship.

Utility objects: Measuring bowls, cattle bell, ladle, vermillion container etc.

Decorative items: Flower vase, door handle, wall hanging, pen stand, paper weight, candle stand, small box, tumbler etc. Various types of animal figurines like horse, deer, elephant, tortoise, peacock, owl etc. human figurines of tribal men and women, set of musicians belong to this category.

Ornaments: Pendants, ear rings, ear studs, necklace, bangle etc.

Price of the objects varies according to the size. The price of the object of 1 ft height is made from 1 kg of brass ranges from Rs. 500/- to Rs. 1000/-. It depends upon design. The artisans in most of the cases get only labour charges, when there is order from traders or middle men, but in case of direct selling they get the market price of their products.

e. Market survey:

Their main marketing center is Bankura, 5 Km away from the village. They sell their products in different fairs and in festivals organized by both State Government and Central Government. Their products are also sold in famous Santiniketan mela , Bishnupur mela, Kalpataru mela of Durgapur, Khadi-o- Hastashilpa mela of Kolkata. Dhokra crafts are also sold in Cottage industries run by the Government. They also sell their products to Mumbai, Goa, Patna, Delhi, Bangalore, Hyderabad and also to other countries such as Bangladesh and Japan.

f. Problems related to the craft

Though in Bikna village number of artisan involved in the craft are increasing day by day, but they are facing a lot of problems at present. There is scarcity of raw materials. They have to depend on the middle men for supply of brass. Increasing rate of price raw material and fuel and scarcity in their supply, loan from money lenders, lack of workshop and training, problem of storage of raw material as well as finished products, lack of capital, suffering from various ailments like breathing trouble, arthritis, skin disease, and problems with hearing.

NISTAD (National Institute of Science, Technology and Development Studies) has taken a number of steps for the development of the craft. They also made fuel saving furnace for the artisans.

5.5 Metal technology of Rathijemapatna in Khordha district of Odisha:

Brass objects in Rathijemapatna are manufactured in two ways; either by beating or by casting scrap metal for the production of decorative and religious objects. However the area is traditionally renowned for wrought metal technique of manufacturing different brass utensils.

a. Raw materials:

Primary raw materials used for the craft is brass and bell metal. Though they are familiar with other types of metals like copper (*Tamba*), Zinc (*Khapara*), Tin (*Ranga*) and alloys, namely, brass (*Pitala*) and Bell metal (*Kansa*). They are also familiar with different types of copper which are locally known as *Baitapata, Kandulu, Katura, Panchumisili* and also of tin namely *Pinaki, Joti and Kulinagar*. Due to unavailability of primary raw materials they have to depend on scrap metal at present. The scrap of brass is known as *Paturi* and bell metal is *Kanti*. The wares produced from these scrap metals are locally called *kama*.

The secondary raw materials required for the craft are soldering material, resin, polishing materials and fuel. Soldering materials are of two types, distinguished as *Pitala pahana*, which consists of borax powder and grains of zinc and brass in 1:2 proportions and as *Kansa pahana*, which consists of borax and grains of bell metal and tin. Soldering materials are mixed in water. Borax powder is locally known as *Tangana*.

Resin (*Jau/Rala*) is made by mixing of powdered burnt brick, burnt cow dung cake and oil. This is used as adhesive to fix the metal objects with lathe for polishing. For polishing sulphuric acid in a diluted form, tamarind, tamarind leaves, stale rice water are usually used. Polishing in buffing machine and also with the abrasive commercially known as Brasso is common practice.

Firewood and charcoal are used as fuel. These are purchased from local markets.

b. Equipments (Plate- 25)**:**

Variety of tools and equipments are used by the Kansari of Rathijemapatna. They use both indigenous and imported tools. They themselves make a number of tools. Different types of tools are used for different techniques.

Hammer (*Hatudi*): Hammer can be broadly classified into two, iron hammer and wooden mallet. The edges of the hammers are square, rounded and flat. The local names of dirrefent types of hammer are *Konta hatudi, Guma hatud, Kachha hatudi, Kanamara hatudi, Phalia hatudi, Kora hatudi,* and *Mathana.* Size of the hammer heads varies between 4 inches to 8 inches in length and 1 inch to 2.5 inches width. The size of the wooden shaft varies from 10 inches to 16 inches with circumference between 2 inches to 3 inches. Different types of wooden mallets such as *Goji, Dihamara, Telimara, Phalia, Ota goli* etc are used for hammering a larger area. Size varies from 10 inches to 14 inches length and 2.5 inches to 4 inches width. Wooden head is generally 12 inches to 14 inches long.

Pincers (*Sandasi*): Pincers are also of various types such as *Ghatibula, Balakara, Phulanakara, Dahan, Kamara, Sanakodi, Ghatidhala* etc. Size of iron pincers varies in length between 12 inches to 18 inches. Long pincers used for bringing out crucible from the furnace is known as *Dhala sandashi*.

File (*Uga*): Different types of files made of iron with wooden handle are used for smoothening rough surfaces. Different types are *Tinikonia, Chauansia, Gola, Mota, Saru* etc. Size ranges from 10 inches to 16 inches and width from 0.5 inches to 1.5 inches.

Scrapers (*Lihini*): Various types of scrapers are used for scraping semi processed metal wares fixed with a lathe. Types of scrapers are *Eka-parastia, Dui-parastia, Guna, Ada, Chuta* etc.

Anvil (*Nehi*): Iron anvils of different sizes are used for keeping wares on it for hammering. It is 6 inches to 10 inches in diameter and 8 inches to 10 inches long. A stone

anvil (8 inches height), known as *Kamgara pathar,* is also used. It is bought from Dhenkanal district of Odisha.

Hand operated drill (*Bhanra*): It is used for boring holes in metal wares.

Blower (*Kalapankha*): Mechanical and hand operated blowers are purchased from hardware stores for fanning the Furnace.

Bellow (*Bhati*): Bellow made of animal hide is used for fanning the furnace in few workshops.

Lathe (*Kunda*): Three types of lathe are found. Indigenous wooden lathe is similar to West Bengal. There is another type of wooden lathe made of *Sal* wood, in which an iron rod is rotated through a circular stone. Machine operated lathe also are used in most of the units.

Crucible (*Koi*): Crucibles are made of clay. Crucibles are made by them as well as purchased from the local markets which are more durable.

Impression pens (*Puara*): Iron gravers are used for engraving designs specially for nameplates.

c. Furnace (Plate- 36)**:**

There are two types of furnaces. The furnace which is used for melting of metal is larger in size. It is made of bricks and mud, circular in shape with diameter of 4 ft with an oven of 1 ft diameter. The height of the furnace is 2 ft from the floor with outlets for air in the lower margin. The smaller furnace is semicircular in shape. The walls are thinner. Bellows are replaced by hand blower. In some workshop old bellows are found. It is made of animal hide fitted with the furnace through an iron pipe with clay head.

d. Workshop (*Sala*) (Plate- 10)**:**

Workshops are permanent and semi-permanent constructed next to their houses. It is mud floored with tiled roofing and sometimes thatched with straw. Ground plan of the

workshop is rectangular. Furnace, tools and equipments are kept in the workshop. The places are fixed for the artisans according to their work. *Garha*-artificer sits first. Infront of him is *Kora*–hammer man. *Pasia*, *Maihi-pasia* and *Pardipasia* hammer men are placed on the right hand side and Bada-Bhatia and Sana-Bhatia hammer men on left hand side. Furnace is fixed at one corner and others are set according to the position. The front and back sides of the workshop are open for ventilation.

e. Technique of making brass objects:

Artisans of Rathijemapatna practice two techniques, such as wrought metal technique and casting in box mould.

(i) Wrought metal technique (Plate- 26)**:**

At Rathijemapatna plates of different sizes are produced by wrought metal technique.

Casting of ingots (Ghatti tier kariba)

First stage is the making of metal ingots (*Ghatti*). The crucibles are filled with scrap metal. After igniting the furnace with fire wood and charcoal the crucible is placed on the furnace. After 2 hours when it attains temperature of 1000^0C the metal starts to melt. When all the metal melts the crucible is taken out from the furnace with the help of tongs. The molten metal is poured into the moulds made of burnt clay.

Enlarging ingots (Chokki Kariba)

The ingots are flattened slightly at first. Two or three flat ingots are hammered jointly. In case of smaller plates a bunch of 17 such ingots are hammered together and for larger plates 4 to 5 are clubbed together for hammering. Hammer men continue hammering until enlarged to a circle of 8 inches diameter. Three hammer men sit in a circular way around the anvil for hammering. An artisan move these flat pieces anticlockwise holding with pincers and others beat with hammers without any collision with each other.

Shaping (Phulana hai)

Shaping is done by four to six hammer men by alternate heating and hammering. Beating is done by six hammer men for two times. Then raising of edges of the plates are done by four hammer men for three times. The middle portion of the plates is shaped by wooden mallet. It is locally called *Chandi maro*. After that it is immersed in water for temper.

Finishing

Finishing is done by the artisans for making the plates even. They try to remove dots and dents produced due to hammering. The work is done after fixing the plates with suitable stakes and with small hammers. Edges of the plates are smoothened with iron file.

Polishing (Kunda)

Polishing is done by scrapers after fixing the plates with wooden lathe, which is operated manually. They also engraved designs with small impression pen or chisels.

(ii) Technique of casting by box moulding (Plate- 28)**:**

Preparation of clay

Artisans of Rathijemapatna are also expert in casting of different ritual items including images of Gods and Goddesses, bells, Snakes and pinnacles of temples. They use box moulding technique. At first the dice of the object to be casted is made out of wood or of metal or plaster of Paris. Moulding clay is first sieved to remove stone or grit and then kneaded with molasses and burnt motor oil. Craftsmen use their hands and feet for kneading. The proportion is 80: 20 by weight.

Making of mould

Moulding box is made of two hollow wooden frames, rectangular in shapes with fastening locking system. Size of the boxes depends on the size of the image to be cast.

The lower frame is covered up with clay. The layer is made smooth and uniform by rolling it with a small iron roller. Then the artisan places the dice of image to be cast on the layer of clay in the lower frame of the box in such a way that the back half of the dice is embedded in the clay layer and the front half of the dice faces up. Then the artisan covers the dice with the clay with gentle pressure of thumbs and palms.

Then the artisan fixes the upper frame of the another moulding box on the lower one and filled up the mould box with clay mixture by hand and foot pressure so that the dice which is embedded in the clay will leave a clear impression when taken out.

The artisan lifts up the upper frame of the moulding box. Then the dice is taken out from the lower frame with care. It leaves a clear impression of front half and back half of the dice inside the Upper and lower frame of moulding box respectively. The artisan cut out small and circular runways linking all the cavities formed by the dice inside. and through the runner molten metal is poured into the mould box. Total process is done very carefully. Then upper frame is superimposed upon the lower. Now the mould is ready for casting.

Melting of metal

At first fuel wood, cow dung cakes and steam coal is fired with kerosene. When the Furnace is charged the crucible with brass scrap is placed on the furnace and covered with broken moulds. After one hour the temperature of the furnace raises up to 1000^0C the metal starts to melt. One or two grams of borax are added which act as flux which make the metal more fusible. Then the impurities are separated from the metals.

Casting

After melting the crucible is taken out from the furnace with long pincers. The metal takes crimson red hue at that time. They put one or two heavy weights on the boxes so that it may not slip when the molten metal is poured into the runners of the upper moulding box. After fifteen minutes the box is opened and new cast image is taken out. It takes four to five hours.

Finishing

After that soldering of different parts are done with welding machine. Then it is scrapped and filed for smooth finish. Then it is polished in buffing machines. At last they apply metallic colour if customer prefers.

f. Costs of production:

For making 9 Kg of brass object scrap metal needed is 15 Kg with a cost of Rs. 5000/-, 10 gunny bags of woods (Rs. 5000/-), paraffin wax worth Rs. 10000/-, 125 Kg of Plaster of Paris (Rs.850/-), 20 packets of clay (Rs. 1520/-), wooden box (Rs. 6000/-), hand blower (Rs. 2000/-). Other recurring costs include buffing machine (Rs. 9000/-), Drill machine (Rs. 3000/-), Buffing soaps and wheel (Rs. 8000/-). Artisans can profit @ of Rs. 200/- per Kg after excluding the costs of production. The market price of the images ranges from Rs. 5000/- to Rs. 50,000/- according to the size and weight of the objects made.

g. Finished objects:

Household utensils (Plate-29): A wide range of variety of dinning trays (*Thali*)known differently are *Dera, Chhecha, Sadha bogi, Pdma bogi, Balesiria, Gesh, Katiphula, Kansi, Parhi, Athakonia, barakonia, Kuncha, Kataki, Gina basa*; different types of plates are *Gesh, Ishika, Panna*; cups like *Balesiri, Dharikata, Gina, Nuangadi, Hatigunji, Balakati gina, Gujari Sina*; bowl for serving watered rice (*Bela*); glass (*Gilas*) of various sizes and shapes.

Cooking vessels are *Handa, Handi, Dekchi*; different types of pitchers (*Gara*); ladle (*Karachhuli*); frying stick (*Chatu*); spoon (*Samkua*);large trays (*Parat*); bucket (*Balti*); Kerosene oil lamp (Dibi); betel leaf container (*Pana-bata*)

Ritual items (Plate-30): Small water pots (*Chhota dhala*); trumpets (*Kahali*); pellet-bells (*Ghanti*); Sonorous plate (*Ghanta*); different types of lamps (*Deepa*) like *Eka mukhi, Pancha mukhi, Sapta mukhi*; lamp-stand (*Deepa rukha*); incense stand (*Dhupa dani*).

Different temple accessories are trident (*Trishula*), Snake (*Naga*), wheel (*Chakra*), sacred pedestal (*Ratnasinghasan*) and icons of different Hindu deities (*Shiva, Kali, Laxmi, Narayana, Rama, Sita, Radha, Krishna, Jagannath, Hanuman*)

h. Organization of production:

There is craft organization. Garha artificer is a skilled artisan and master craftsman who control and monitor the manufacturing process. The *Kora* is also a skilled crafts man who performs the activities of beating, shaping and finishing. *Pasia* is a hammerman who is assigned to further shaping and finishing. In bigger workshops other hammer men like *Pardi-pasia*, *Majhi-pasia,* who sit in the centre with *Pasia*. *Bhatia* looks after the heating of furnace, operation of bellow or the mechanical blower besides hammering. Other jobs like carrying of water, cleaning of ashes, cleaning of floor and utensils are performed by unskilled labour.

i. Market survey:

Main marketing centre of these brass items are Balkati market, Uttara market and Bhubaneswar market. They buy objects from the artisans and sell both in whole sale and retail prices. Different brass and copper items from different district of Odisha like Ganjam, Nayagarh, Puri and also from other parts of the district Khordha are sold in the brass and bell metal shops in Balakati, Uttra and Bhubaneswar. Light weight materials made in Muradabad are also found in the market, but sell of this product is minimum.

j. Problems related to the craft:

Scarcity of raw material is one of the reasons of low production. Beside these a number of problems are identified. They are as follows: (i) objects are produced by traditional technology, (ii) unwillingness for adapting new technology, (iii) no direct selling, (iv) dependency on middlemen for supply of raw materials, (v) no capital for independent business. A number of attempts are made by the State Government (DIC) for development of the craft. A cooperative also was introduced for financial assistance, supply of machinery, workshop facilities for the artisans were made. This is not

functioning at present because of their internal dissension. In most of the cases artisans could not repay the loan taken. Artisans are of opinion to form cooperative society with small groups, which may function properly. Beside they are suffering from numbers of physiological problems like breathing problem, low vision, arthritis and skin diseases.

5.6 Lost wax process of brass casting followed by the Ghantara in Sadeibereni in Dhenkanal district of Odisha:

The technique of lost wax process of brass casting is observed among the Ghantara community of Sadeiberni in Dehenkanal district of Odisha. They are traditionally engaged with the indigenous lost wax process of metal casting.

The *Cire Perdue* casting (lost wax process) is an age-old craft of metal casting in which the wax is replaced by metal. It represents elegant workmanship specially for manufacturing art wares in nonferrous metal alloys, embodying the traditional motifs and designs with exquisite style. Conventional shape and design maintain the folk characters and propagate the uniqueness of the craft

a. Raw materials:

Development of brass craft usually depends on the availability of suitable raw materials. Basic raw materials used are brass Scrap (*Pitala*), bee Wax (*Maham*), mustard oil (*Sorshu tel*), resin (*Jhuna*). For making mould clay from termite hill(*Hukka mati*), clay from agricultural field (*Kheti mati*), husk (*Tush*), jute(*Akkha*), cow dung (*Gobor*) are needed. For firing they used Wood (*Katha*) from the surrounding jungle. Except brass scrap most of the items are collected from surrounding area.

b. Equipments (Plate- 31):

Chisel (*Uga*): This tool is made up of iron. It is purchased from the local market. Size varies from 3 inch to 4 inch long having a straight cutting edge. Width varies from ¼ inch to 2/3 inch. This is used for wax designing.

Wooden press (*Muthua*): This is a flat hard wood for pressing wax on the wooden slab locally called '*Pirha*'. Maximum length is 4 inches and breadth is 2.5 inches. The width is 1.3 inches. The upper portion is convex in shape. It is made up of Sisso wood (Dalbergia sissoo).)

Hammer (*Suti*)**:** Hammer is made of iron and is fitted with a wooden shaft. It is usually manufactured by local ironsmith and the handle is prepared by them.

Divider**:** A geometric divider having two equal sides is being used for carving out circles.

Iron knife (*Momkati*)**:** Knife is carved out from single metal piece of iron. Size varies from 4 inches to 6 inches.

Wooden pincers (*Chipna*): A forked piece of bamboo is used as pincers. It is used to hold the mould during firing. It is 18 inches long.

Pointed wooden tool (*Sulka*): It is also made of Sisoo wood. It has a pointed end with blunted base. The cross-section is circular. This is used for wax designing. Length varies from 4 inches to 5 inches.

Tool for making wax wares (*Janda*): It is a composite tool for making wax wires (*Mahama guna*) for producing intricate designs. The tool has four parts. Brass cylinder (*Thesa nala*) is hollow, flanged and 5 inch long. Wooden piston (*Thesa nala katha*) is made of solid wood with a hole same as the diameter of brass cylinder. Four wooden bars (*Katni*) are used for giving pressure. Perforated metal disk (*Chaki*) is fitted at the mouth of the cylinder.

Wooden Plank (*Pirha*): A wooden plank is used for shaping and rolling of wax.

Single pan balance (*Bisa*): This is made up of wood. It has single pan hanging from one side of the wooden bar. The finished object is measured by fitting the balance in a particular unit.

Furnace and Bellow (*Dhokna*): The furnace is operated in the open air and sometimes under the shade. It is circular in shape with 20 inches in diameter and 12 inches in depth. Bellow is fitted with the furnace through a long bamboo pole with clay mouth. Bellow is made of hide of goat and is operated by hand (Plate-36).

Bamboo pipe (*Basanala*): A hollow piece of bamboo is used as blower. It is 8 inches long.

Big knife (*Katri*): It is used for cutting the bees wax wires into the desired sizes and shapes.

Thorn of porcupine (*Jhinka kathi*): This is collected from the forest and used as socket of different boxes.

Broken earthen pot: Broken parts of earthen pots are used for preserving heat.

c. Process of manufacture:

Two techniques are followed hollow casting and solid casting for making different brass objects.

(i) Hollow casting method (Plate-33)**:**

Predesigning stage

Preparation of mould

The mould is made of clay. Clay collected from agricultural land and termite hill, is powdered and properly mixed with the husk. Husk is used as temper which prevents cracking during firing. Clay from the termite hills are used because it is sticky in nature and devoid of grits. Then clay moulds are dried in the sun. The outer surface of the mould is smoothened by rubbing with broken earthen wares. This surface is again smeared with semi liquid cow dung paste. After drying it become ready for design.

Preparation of the wax

Bees wax, resin and mustard oil are mixed in a definite proportion and is boiled. After melting it is sieved through a cloth over a pot of cold water. It becomes hard when cooled down. Artisans cut the requisite amount with iron knife and slightly melt for further work.

Designing and covering of mould

Preparation of wax wire

Wax is softened by slightly heating and threads are produced by pressing in wooden piston (*Jonda*). Moulds are then covered with designs made with wax wires. Common designs are circle (*Chaka*), wavy lines (*Dhanda*), dots (*Rua*), straight line (*Satta*), spiral (*Mora*), circle (*Chandia*). In spite of these a number of naturalistic and geometric motifs are used for designing on moulds.

Making of wax channel

An elongated channel of wax is fixed with the mould. It will be act as runway of molten metal during casting.

Covering of mould

Designs are covered by another coat of clay. This clay is prepared by mixing of clay from agricultural field with cow dung. Then second coating is applied with mixing the clay from termite hills and paddy husk. Then it is dried in the sun.

Precasting stage

Making of crucible

Crucible (*Koi*) is made of clay of termite hills mixing with paddy husk and sometimes with jute. It is hollow and elongated in shape with flared mouth made at the

highest point of the mould. These are put in the sun and sometimes beside the furnace for drying.

Filling of crucibles with metal scrap

Brass scraps are broken into pieces. Crucible is filled in with broken metals and covered with clay. Then the total mould is again smeared with clay coating and ash is spread over it. Now the moulds are ready for casting.

Casting

The furnace is prepared either by fuel wood or by charcoal obtained form local market. Fire is controlled by means of the bellows. When the furnace attains the temperature of 1000^0C the metal starts to melt. It takes about one and half hour. The Artisans by experience understands the condition of melting from observation of colour of flame. When the whole metal is melted the colour of the flame becomes yellowish as well as greenish. Total casting process continues for two and half hours to three hours. Then it is taken out from the furnace with bamboo pincers and moved in upright position to spread the molten metal throughout the mould. Metal covers the vacant area produced by the release of wax during heating. After casting water is sprinkled on it and cooled down gradually.

Finishing

Then cooled mould is broken and replica of wax mould comes out. Then it is cleaned with hard brass. These items are famous for its antique look but at present day they are using metallic colour as per the demand of the customers.

(ii) Solid casting method (Plate-32)**:**

In case of solid casting method core is prepared from wax instead of clay and it is again decorated with wax designs. Then it is covered with the clay mixture. Method of casting is the same. Objects produced by solid casting methods are heavy in weight than the objects produced by hollow casting technology.

d. Finished products (Plate-34)**:**

Ghantara manufactures a number of brass object, which include decorative items, ornaments, ritual items etc. The traditional items include various ritual items and ornaments. Earlier they produced bangle (*Khadu*), anklet (*Payari*), toe ring (*Mudi*), for the tribal people inhabiting in the area. But at present due to high price they do not use these heavy weight ornaments.

The household utensils are measuring pots (*Mana*), coin box (*Anta suta*), cigar, pipe (*Kupi*) and boxes of different designs.

Ritual items are lamp (*Jagor*). They make different lamp stands with single lamp to multiple ones. Lamps on the back of the elephant are beautifully decorated. Images of different Hindu God and Goddess (*Shiva, Durga, Ganesh, Laxmi, Saraswati, Hanuman*) are also made. Other traditional ritual items are bell, pellet bells, garland bell for hanging on neck of cows, milk container for lord Shiva, talisman or amulets.

Decorative items are pen stand, candle stand, door handle, Fang- Sui items, decorative container, Figurines of tribal man and women, animal figurines including elephant, tiger, horse, frog, tortoise, bull are made by lost wax process. These are made as per the demand of the people. Now they are using golden metallic colour for furnishing.

e. Problems related to the craft

The artisans of Sadeibereni in Dhenkanal district of Odisha are facing a number of problems related to the craft like scarcity of raw material, traditional time consuming technology, low profit, old designs and limited demand. They have to depend on local traders or middlemen for supply of raw materials. Intervention of ORUPA (Orissa Rural and Urban Producers' Association) have taken a number of steps for development of craft. These are long term financial assessment, minimization of the cutting cost, enhancement of productivity and quality, increased market price and business alliances. There is training programme from district level for increasing awareness about the process of production and quality and also the process of exploitation of middlemen and

traders. DIC, Dhenkanal also provided money for the development of the craft. 8 SHGs are functioning in the area. Cooperatives are created with a number of artisans. Name of the cooperatives are Navajeeban Industrial Co-operative Society and Maa Mangala Dokra Samity. Earlier they only got the wage/piece on the basis of rate. Now they are aware of the market strategy and proper price of the objects. At present they are participating in different fairs and festivals for selling their products directly. Some of them also travel abroad for exhibition of their products.

Their price of their products ranges from Rs. 400/- to Rs. 500/- of objects of 1 kg weight. The price also varies according to the design of the objects. Except direct selling in case of fairs, they only get the labour charges.

5.7 Changes:

Change is an incessant process which takes place in almost every phase of human activity. People adapt themselves with new technology and discard earlier. It is also controlled by norms and values. Change is found in two aspects one in the technology and other is the people associated with the craft. Changes in technology are found in the form and nature of raw materials, techniques, equipments and finished products.

Changes in resources

Earlier the artisans made alloy from virgin metals. Due to scarcity of raw material they are reusing the alloy at present. Metal scraps are supplied by the traders. This is common scenario of West Bengal and Odisha. In case of lost wax casting the supply of wax has been minimized for rapid deforestation. Artisans of Bikna in West Bengal were forced to use resin mixed with tar or bitumen as a substitute of wax. In Sadeibereni, Odisha artisans are using paraffin wax instead of bees wax at present.

Changes in technique

Changes have been noticed in different aspects of the technique. Artisans of Sadeibereni in Dhenkanal district in Odisha prepared wax threads with the help of wooden press now they are using modern metal tool. Equipments are also changed with adoption of new technology. In Shibaloy as the objects are moulded in machine made dice. Use of traditional tools like hollow iron frames, different types of hammer have been minimized. Earlier there was bellow made of animal hide for fanning furnace both in Odisha and West Bengal. A present hand operated blower is used for fanning the furnace. As the price rate of brass is increased people cannot purchase heavy weight materials. So artisans adapt slowly with the technology of making light weight materials because of the high price of brass. In Shibaloy in West Bengal artisans are practicing of making of brass objects of low weight. This is possible because of the adoption of new technology of dice mould in electric operated machines. Hand operated lathe for polishing of metal objects are replaced with electric operated lathe both in West Bengal and Odisha. Production of brass sheet not only modified the technology as well as the social life of the people attached with the craft. Change of technology also has effect on the norms and values of the artisans associated with the craft as well as their organisation of production and economic aspects of the communities.

Changes in form

Form and designs also have changed in different areas under study with the demand of the society. In case of lost wax process artisans are producing more decorative objects than ritual objects. These decorative items have demand in urban areas. This scenario is common both in Odisha and West Bengal. Not only form but design also has changed. Dokra art objects are famous for its antique look but at present these are painted with metallic colour for gorgeous look as per the choice of customers.

Rate of change is minimized in case of production of brass utensils both in Odisha and West Bengal. Artisans of Shibaloy diversified their products. Earlier they made three types of pitchers. New form of pitcher is introduced with earlier two. In Bishnupur new

designs are engraved on the pitchers as per the choice of the customer. Variation is also noticed not only in form but also design in Rathijemapatna in Khordha district of Odisha. At present artisans paint small pitchers and ritual objects with metallic colour.

In spite of these changes the tradition is persisting in the area and may be continued. Craft is hereditary in nature which is also another factor for continuing of the craft.

5.8 Reasons behind leaving the traditional occupation:

A study is made among those people who belong to brass working communities by caste but do not practice brass work at present. A number of reasons have come up from the interview of the people. These are as follows:

(a) non practice of brass work for a long time, (b) shifted to other occupations which are stable and more paying, (C) due to ill health gave up the work, (d) lack of interest and opportunity for learning the technology of making brass objects, (d) due to fall in demand, less amount of profit and thinking that the craft has no future.

The reasons behind leaving the job also vary from place to place. In case of Khagra in Berhampore most of the families left the occupations for a long time and members of new generation are not interested to carry on with this job. The artisans are also not interested to train their next generation. In case of Kunjaghata in Berhampore new generations are also being involved with the craft. As there is demand for brass pitchers they can earn some money if they learn the craft. On the other hand people of other caste groups are involved with the craft.

Similar situation is noticed in Shibaloy, North 24 Parganas district of West Bengal. In case of Bishnupur the artisans are in two minds about giving up the brass work. According to them the brass work is not profitable. But there is no provision for taking up higher education or for any professional training in the area. They had no

opportunity for getting any other job. It appears that a number of families are in hand to mouth condition. Some of them are working as daily labour for their livelihood. In Rathijemapatna, most of the families are giving up brass work because supply order is not enough and profit is marginal. A number of artisans left the job due to illness like arthritis and breathing problems. Most of the artisans informed that scarcity of raw material is the main reason for not continuing brass work. They are of opinion that if they can get raw material in proper cost they can start the work again. It is clear from the above study that the artisans who are engaged in traditional technology are in a very pitiable condition. On the other hand the artisans who adopted the technique of sheet metal work the job opportunity is increasing day by day.

In case of lost wax process nobody is thinking of leaving the traditional job. They are more or less satisfied with their income. They get the order for brass work frequently. Alternatively they can work as daily labour. The motivation for higher education is less and they are being involved in the craft from their childhood, even though scarcity of brass is also present there. They are trying to cope up with the situation with their inherent indigenous knowledge of metallurgy.

5.9 Similarity of brass technology of the present day with Protohistoric period:

The technology of lost wax process of metal casting is indigenous in nature. Probably it was the earliest technology of making brass ornaments in eastern India. The evidences of brass ornaments suggest that those were probably made by in lost wax process. The alloy was prepared by combining of copper with zinc over charcoal fire. This is suggested by the experts from Metallurgy department of Jadavpur University. They also suggested that Zinc and copper were not extracted separately from the ores. There were lots of impurities present in the said alloy (Ray *et al.* 1993). The broken part of a crucible was found from the site. Slags attached to it were also analyzed. Runnels for moving of the molten metals into the gaps produced by melting of wax are also found in the crucibles. Evidence of internal breakage, which is also common occurrence in lost

wax process of the present study, proves the point. In this way the present study helps to reconstruct the brass technology of past. Present study is of immense help in understanding of the past technology of the metal craft. This kind of study may help to reconstruct the manufacturing technology of metal artifacts which may come out in future excavation of ancient sites of eastern India.

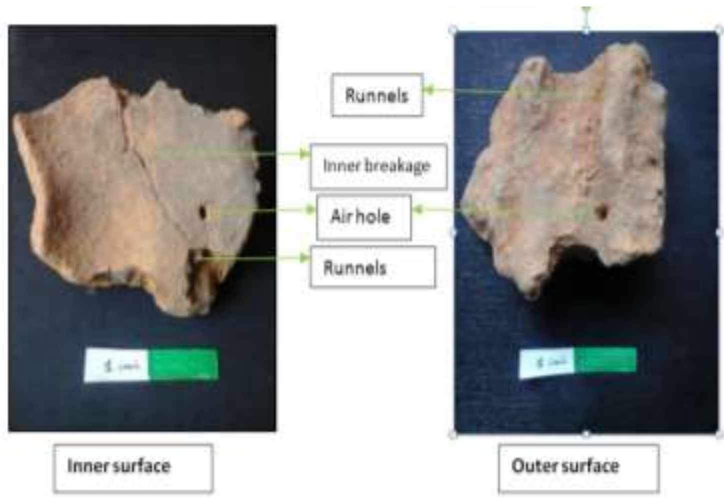


Plate 4: Crucible found from the site Kuanr in Keonjhar district of Odisha

Different techniques of making brass objects practiced in eastern part of India have similarities with the techniques reconstructed from the findings of Indus valley civilization. Similarities also have been found in the method of casting and fabrication of objects (Kenoyer and Miller 1999). Earlier the metal smiths of eastern India were expert in lost wax process of metal casting utilising the natural resources of ores. Later different techniques were adopted through time.

5.8 Chapter summary:

Technology of making brass objects in different parts of eastern India is discussed in this chapter. Five communities are selected for the present study. Out of them three are from West Bengal namely Kangsabanik, Karmakar and Dhokra Kamar. Rest two are from Odisha namely Kansari and Ghantara. All of them practise brass work in traditional

way. Different communities are expert in different types of work such as wrought metal technique, cast metal technique and sheet metal technique. They have inherent knowledge of different aspects of technology and also about preparation of metal as well as reagents used for lowering of melting point. They also have knowledge about properties of metals as well as about making alloy by different metals in right proportion. Artisans also have knowledge about the melting points of different metals and suitability of metal for performing of different techniques.

Not only technology but differences are noticed in objects produced. Various objects are manufactured according to the demand of the society. In Khagra area of Berhampore artisans are expert in making household utensils out of brass and bell metal. Different types of trays, bowls and glasses are manufactured by wrought metal technique. However in Kunjaghata artisans are engaged in manufacture of pitchers from brass sheets. The artisans of Shibaloy also make different types of pitchers from brass sheet. They adopted new technology of making utensils like pitchers, handi and small pitchers by moulding in machine operated dice. Bishnupur in Bankura district of West Bengal is also famous for making house hold utensils mainly pitchers, glasses and bowls. These are produced by casting method in clay moulds. Dhokra Kamar of Bikna in Bankura district of West Bengal practice lost wax process of metal casting. Ritual and decorative items are their primary products. Kansaris of Khordha district of Odisha make different types of household utensils and ritual objects. They employ wrought metal technique, cast metal technique and sheet metal technique. Ghantara of Dhenkanal district of Odisha practice lost wax process of metal casting for making various ritual and decorative items.

Equipments and raw materials used for the craft vary according to the nature of technology. In Khagra area metal ingots are produced by melting of metal in furnace. However this type of furnace is absent in Kunjaghata as they practice sheet metal work. Other equipment has similarities in those areas. As the artisans of Shibaloy practice both traditional technique and newly adopted technology equipment used are both traditional and modern types. The new machinery are of high price. Utensils are made by casting technology in Bishnupur in Bankura district of West Bengal. There is an elaborate

process of making of mould utilising the natural resources of clay. This elaborate technology of making mould is absent in other areas. The instruments for finishing are not so much different compare to those of Berhampore. Equipments used by Dhokra Kamar of Bankura are simple type made by exploiting the natural resources. They also depended on their surrounding environment for collecting raw materials needed for the craft. As the Kansari of Khordha district of Odisha practice different technologies of making brass objects, there are varieties of equipments suited for different technology. Whereas Ghantra of Dhenkanal district of Odisha practice lost wax process of metal casting with their simple tools made by exploiting the natural resources and raw materials needed for the craft are collected from surrounding environment. Types of furnace also vary according to the nature of technology. Workshops are more or less same in all the areas. But in case of artisans who practice lost wax process have no separate workshop. Most of the work is performed in their courtyard. The scenario is common both in West Bengal and Odisha. Scraping and polishing are not practised in lost wax process.

Market survey reveals an interesting phenomenon of business networks in different areas. Each object produced in an area have some special characteristic features and are distributed in different markets of the other areas. The products also serve different communities living in an area. Artisans of different areas are tied with one another by the elaborate business network, not only within the district but also throughout the country.

Problems are part of the life. Brass artisans are suffering from lots of problems regarding their health as well as different aspects of technology. The primary problem in each of the areas is scarcity of raw material. Different attempts have been made by State Government and Central Government. They took steps for uplifting the craft as well as for raising standard of life the artisans. In spite of these the craft is sustained at present. Not only the craft, the knowledge, beliefs and practices associated with the craft are sustained for a long period of time. It has immense significance on mobility and dynamicity of the communities. It may as well act as a bridge between past and present, though changes have not been ignored.

5.10 CASE STUDY

Case 1:

Respondent is 76 years old male belonging to the caste group Kangsabanik. He resides near Khagra area in Berhampore in Murshidabad district of West Bengal. He was born in 1930 in Rajsahi in undivided Bengal, now Bangladesh. At Rajsahi they had the workshop for brass and bell metal adjacent to their house. His schooling was up to class VIII standard. He started helping his father in the business from the age of thirteen years. As his father was illiterate person, he kept the records of accounts of their business. He joined his father's workshop in 1943 as an apprentice. The workshop was big and 14 labours worked there. They also have a house in Berhampore. During communal riot in Bengal he stayed in Berhampore. He worked in the workshop of his brother-in-law in Khagra in Berhampore. After independence he returned to Bangladesh and started a new workshop there. He got married in 1965. Bride was also from Rajshahi belonging to the caste Kangsabanik. However, the family became engaged in jewelry work. Then he permanently settled in Khagra and bought a plot of land in1971. He has a small workshop adjacent to his living quater. There was demand of brass and bell metal that time and these were exported from Rangpur, Dinajpur and Parbatipur. Labour charge was Rs. 4/- per day at that time. He has for sons. His elder son is 42 years old and his occupation is tailoring. side by side he also practices brass work. His wife is from Swarnabanik caste. Next son is of 40 years old and educated up to class VIII standard. He resides in Maldah and is engaged in repairing works of brass and bell metal. The other son is 32 years old and is educated up to class VIII standard. He is a salesman and also practices brass work. Youngest son is 30 years old. He is also educated up to class VIII standard. He is a labour of brass work mainly engaged in polishing work at different workshops. Respondent is now suffering from breathing problem. He still practices brass work in small quantity specially makes small bowls, cups, plates, spoons etc.

Case 2:

Respondent is 81 years old male, resides in Kansari Para Lane in Khagra in Berhampore in Murshidabad district of West Bengal. He is educated up to primary level and started to learn the technology of brass and bell metal from his grandfather when he was 12 to 14 years old. His elder brother was also engaged in brass work and sold their agricultural land for increasing the capital of their business. He told that there are workshops of brass and bell metal in almost all the houses and sound of hammering made a noise in the area. At that time they used to make alloy from virgin metals. They always prefer to work with an alloy of copper, tin and zinc. They had big workshop and their relatives also came from Bangladesh and joined as labour in the workshop. Due to increasing rate of copper the work hampered and they started to make new objects from older ones, which is locally called '*Nolok er kaj'*. According to his opinion the involvement of middle men is one of the reasons of diminishing of the craft. He got married when he was 25 years old. Bride is also from Kangsabanik group. His elder son is 48 years old and is engaged in brass and bell metal work. His younger son is 42 years old. He is educated up to class VIII standard and now is engaged in business of grocery shop. His wife is also from Kangsabanik caste of Nadadwip in Nadia district of West Bengal. Respondent got arthritis in finger, which is locally called *Jahar bat*. He was cured after surgery and at the age of 70 he slowly left the work and now is spending his retired life. He is much nostalgic remembering of the glorious past of the craft of brass and bell metal in the area.

Case 3;

Respondent is 48 years old male. His workshop is in Khagra in Berhampore area of Murshidabad district of West Bengal. He belongs to the caste Kangsabanik. He is primary school level educated and is engaged in the work from his childhood. He eagerly joined their hereditary occupation. His father and grandfather were brass and bell metal artisans. He works from 8 am to 8 pm, with an interval of 1 hour. His income is Rs.

5000/- per month. He is expert in both brass and bell metal work. His workshop is brick walled with tiled roofing. Ground plan is rectangular. It is 20 ft by 12 ft in measurements. Two sides are open and floor is of beaten mud. He is the master craftsman and hires labour for hammering, scraping and polishing. He is expert in casting as well as wrought metal technique. He makes different types of household utensils from brass and bell metal, which includes different types of trays, plates, cups, dishes, spoons, and feeding spoons. He makes objects as per the order from shopkeepers of Khagra market. He got married at the age of 26. His wife is from Kangsabanik caste of Nabadwip in Nadia district of West Bengal. He has two offsprings, a daughter and a son. Daughter is 22 years old and doing post graduation. His younger son is 12 years old. He is in primary school. Respondent do not want to involve his son in this work. According to him it is a dying craft and he also sited some reasons for vanishing of the craft like limited use, high price, scarcity of labour and low income. Due to these reasons people do not want to involve in the craft at present. He is not optimistic about the future of the craft.

Case 4:

Respondent is 76 years old male residing in the hamlet known as Kamar Para in Motukganj in Bishnupur in Bankura district of West Bengal. He is education is up to primary level. He was engaged in brass work when he was 15 years old. His grandfather made anklets and bangles for Santals residing in adjoining areas. Making of brass pitcher started from the time of the respondent's father. He has four sons. They are 39, 34, 28 and 25 years old respectively. All of them are educated up to primary and are engaged in making of brass pitchers. Their workshop is attached to their house. It is brick built with tiled roofing and mud floor. It is on a raised platform from the road. The workshop is quite big in size and rectangular in ground plan. It is 30 ft x 25 ft. The furnace is rectangular in shape and 18 inches high from the floor. Before the casting starts there is an elaborate process of making moulds. Moulds which were prepared earlier are kept in the workshop. A total day is spent for carrying out the casting operation. Dried up crucibles are fixed with the moulds and is covered up by a coat of clay mixed with jute

and paddy husk. Then it is dried up by the side of the furnace. The furnace is prepared with cow dung cake and charcoal and when it is charged the mould with crucibles are kept into the furnace. The furnace has two ovens. Two different parts of the mould are heated in two ovens side by side. Furnace is generally operated by hired labour, who belonged to different caste groups. Casting is done for three hours. After melting of the metal it is taken out from the furnace with the help of big pincers and kept in an upward position. After a few minutes it is kept in an inverted position so that the molten metal flows in to the gap of the moulds. After that the mould is cooled down by sprinkling of water. Then the crucible is detached from the mould which may be used for further casting. Two parts of casted pitchers are taken out from the mould. The total process of casting continued from 6 am to 1.30 pm. Respondent supervises the total work at present. Due to old age problem he avoided the laborious work. He also stated that this type of pitcher has demand in Bihar. The problems regarding the continuation of the craft are two. One is the insufficient capital and other is labour problem, as at present a number of persons are shifting to other occupations.

Case 5:

Respondent is a male of 26 years of age. He belongs to the community Dhokra Kamar of Bikna village in Bankura district of West Bengal. He is primary level educated and is involved in the craft from his childhood when he was 12 to 14 years old. His father was master craftsman and died 5 years ago. He lives in a joint family with his two brothers and widow mother. He also has a step mother, who lives in a separate household with her son. Occupation of the respondent is making of brass objects by lost wax process. He makes various types of figurines of animals, birds, images of God and Goddess and a number of decorative items. Besides traditional equipments he also uses polishing machine for better finishing. It was arranged by the Regional Design Centre (Eastern Region), All India Handicraft Board. He also has training from Handicraft Board. He received prize in the district level in 1988 and state level in 2001. His wife is also from the caste group Karmakar. Her age is 23. She was born in Raiganj and there

was a workshop for making brass and bell metal in her father's house. They have two children. The Son is 5 years of age and studying in class I. His daughter is 3 years old. He works from 8 am to 8 pm with an interval of one hour for lunch. When they have more orders the work continues up to 12 at night. He is also very optimistic about the craft. He has no objection if his son takes up the craft. He discussed about the problems they faced. First is the scarcity of raw material. Due to unavailability of raw material he cannot take order from the customers and in most of the cases they have to depend on middlemen and traders. Another problem is that there is no particular workshop in their village and most of the times they practice the craft in their courtyard. Problems also arise from the casting in common furnace.

Case 6:

Respondent is a male of 61 years of age. He belongs to Kansari caste and resides in the village Rathijemapatna in Khordha district of Odisha. He was born in the village. His father was brass and bell metal artisan as well as a cultivator of land. After completion his higher secondary (P.U) in 1967 he joined in Co-operative society and became the secretary. He got married in 1969. Bride was from Kansari community of Kantilya of Nayagarh district of Odisha. In the year 1978 he joined the Central Government Census Department in Berhampur in Odisha. He resigned from the job when he was transferred to Koraput. Then he again joined in the cooperative society. After the demise of his father in 1982 he started the casting method of making brass images. He has three daughters and three sons His two daughters are married in the same caste group. His three sons are engaged in brass casting of different images. They have a single workshop and three brothers work together there. Elder son is a graduate and he has network with other parts of the state and also able to bring order from customers. As he is educated to a higher standard, he introduced a number of scientific techniques in metallurgy. He instructs his two younger brothers for making of mould. During casting of metal he takes the responsibility of total process from melting to casting in the mould. Now the respondent is suffering from arthritis. He took part only in finishing work.

Villagers respect the respondent as he has capability of organizing groups for forming a cooperative. They also take advice from him in any crisis related to the craft. According to him illiteracy is one of the problems for diminishing of the craft, because they are not able to get the access of the facilities given by the Government unless they have minimum education.

Case 7:

Respondent is a 50 years old female. She resides in the hamlet Nabajibanpur in the village Sadeiberni in Dhenkanal district of Odisha. She belonges to the caste group Ghantara and is born in the same village. She is primary level educated and started to be involved in the craft from her childhood i.e. 10 to 12 years of age. She got married at the age of 22. Respondent is expert in lost wax process of metal casting. She is capable of performing different stages of production. She has enough knowledge of metallurgy. Respondent showed the process of making brass bangle (*Batafal kharu*), which was used by tribal women in earlier days. The researcher showed her the ornament, which was collected from the Chalcolithic site Kuanr, in Keonjhar district of Odisha. At first her son tried to replicate the bangle, but he failed. Then the respondent made a similar one with her inherent technical knowledge. The bangle was made by solid casting method of lost wax process. At first she built a replica of the bangle from wax. Then covered up it with first coat of clay and dried. Next day she made the crucible and filled it up with pieces of brass and covered it up. On the last day she did the casting method. Casting started in the early morning at 6 am and continued till 11.30 am. She is also capable to understand about melting of metal by observing the flame that came out from the crucible. Besides brass work she is involved in household work as well as in different agricultural activities like husking and boiling of paddy. Her husband has business of grocery shop. They have two sons and a daughter. Her two sons are involved in the craft. She got award from State Government and take part in different workshops and fairs in the states as well as outside the states and abroad. She is also an elected member of the Panchayet. She solves problems that crop up in the village. She is optimistic about the future of the craft.

CHAPTER VI

6. SUMMARY AND CONCLUSION

The present study is on brass, though bronze and bell metal also have been taken into account to understand the primacy of brass in eastern India. Technology of brass is also related to the technology of mining and smelting of copper and zinc. Metallurgy played a vital role in the development of civilization. There are a number of stages through which metallurgy developed. These are shaping of native copper, annealing, smelting and casting respectively. Form of raw material also changed through time. At first raw metals collected from the mines were directly used for metallurgy. There were more impurities. Gradually the metal smith learned the technology of purifying the metals from impurities and then making of alloy from virgin metals. Alloys are made of two or three virgin metals. These are mixed to increase the metal's strength, to make it more resistant to corrosion, and change its colour. Brass is an alloy of copper and zinc. Zinc contains less than 98% of copper, other metals may be present in small quantity which is always subordinate to that of zinc.

There is East-west debate about the origin of metallurgy. Copper metallurgy was earliest in origin in South West Asia around to 11th to 9th millennium BCE. From this core area it spread to other parts of the world. Bronze emerged in Southwest Asia at the end of 4000 BCE and the trait diffused to Central Europe and Central Asia. In China bronze developed around 2000 BCE and in Indus valley around 2700 BCE. However true bronze objects have not been found from Harappan civilization. It may be due to the scarcity of tin in Indian subcontinent. In other parts of the Indian subcontinent beyond the Harappan civilization, copper technology flourished during Neolithic and Chalcolithic period. In eastern part of India brass is of early in origin during Chalcolithic period. A number of brass objects have been found from Keonjhar district of Odisha by Prof. Ranjana Ray (1993).This alloy was produced by smelting of chalcopyrite and zinc ore in charcoal fire as per the metallurgical analysis done by the Metallurgy Department of

Jadavpur University. True brass developed in China in 1st millennium BCE. So it may be said that eastern India excels in brass work from Chalcolithic period.

There is evidence of early copper and zinc mining in India. According to Ghosh (1981) copper metallurgy was flourished in Chotanagpur Plateau from where the technique traveled to the east through Bankura-Purulia- Midnapur track. In eastern India zinc deposition are found in Manbhum, Hazaribagh, Bhalgalpur, Singbhum and in different parts of Odisha (Rao 1964). Prehistoric men perhaps were aware about these sources of zinc. The availability of zinc led to the early metal smiths for production of brass in eastern part of India. A number of communities practice brass work in different parts of eastern India at present. For the present study communities of Kangsabanik, Karmakar and Dhokra kamar in West Bengal; two other communities namely Kansari and Ghantara of Odisha are taken into account.

Special attention is given on the socio-economic aspects, technology of production, mode of change among the craftsmen, their production and types of objects they made. It may throw some light on ancient remains of brass and the artisans associated with the craft of the region during prehistoric and prortohistoric periods.

A review is made of the allied works done in Indian context as well as abroad. These can be classified into two groups. One group is the literature regarding the archeological evidences of brass and beginning of metallurgy in the subcontinent of India. Another group involved the study of contemporary brass objects, its manufacturing technology and the artisans associated with this technology. Most of the work was dealt with the indigenous lost wax process of metal casting, which is distributed throughout the world from ancient time period. Mukhejee (1978) has made detailed study of metal craftsmen in different parts of India. As the literature survey on work conducted by anthropologists on brass working in eastern part of India.

Methodology has been built up in accordance with the problem. Sources of data are two, one from the archeological context and other data have been collected from the present day brass working communities. Area was selected on the basis of tradition of

brass work which persisted for hundreds of years. Data on present day brass working have been collected from different communities traditionally engaged with the craft. They are distributed in different parts of eastern India. For the present study emphasis is given on Odisha and West Bengal. Selection of villages and townships are made with a view to understanding the brass working community in relation to the other groups belong to both tribal groups and caste groups. The study of socio-economic aspects of present day brass working communities is important.

Methodology is also built up to study different aspects of technology including the sources of raw material, technique of manufacture, finishing of brass objects as well as skill. Structural and functional aspects of different objects they made had been taken into consideration. The variation of morphology is related to spatial and temporal differences. It also highlights the diversity of culture, tradition and value system of the people making and using the brass objects. Demand and supply of metal objects are related to the demand of the society and market network. It is also related to utility and function. Finally the change occurred both in the material level as well as social and ideological level regarding the brass is studied. For collection of the data different methods are followed such as observation, both participant and non-participant; interview both structured and unstructured schedules; case study and schedules with both open and close ended questions were used. Analysis is done on the basis of statistical and descriptive methods.

Eastern part of India is selected for the present study. The area is selected for two reasons; firstly, there is evidence of brass from protohistoric period and secondly; a number of communities are still practicing brass works in a traditional way. Eastern India primarily covers major geo-political units of Bihar, Jharkhand, Odisha, and West Bengal. The region shows diversity in geological setting as well as in communities belonging to different language groups and of different religious faith. The area is composed of varied geological setting from Paleozoic period to recent with intermediate quaternary deposition. For this reason the area has rich deposition of rocks and minerals, which is also one of the reasons for development of metallurgy from prehistoric past. Mineral

resources are important in the present study in terms of the quality and availability of important raw materials for brass work such as copper and zinc. Climate and vegetation is tropical monsoon type. A number of tribal groups live in different parts of the region. For the present study emphasis is given on Odisha and West Bengal. However distribution of brass working communities in other states of Bihar and Jharkhand also has been taken into account. Villages were selected both from rural and urban areas. The communities who are engaged in lost wax process of metal casting live in rural areas and the communities who practice technology of wrought metal technique and sheet metal technique live in urban set up. The artisans live near the market areas in case of Berhampore in Murshidabad, Bishnupur in Bankura and Shibaloy in North 24 Paragans of West Bengal. The artisans of Rathijemapatna in Khordha district of Odisha also live near the market place. This is due to easy availability of the raw materials necessary for the craft as well as for selling their products. As the technology is very laborious and most of the artisans have to engage themselves in the craft almost throughout the day, they have minimum time for selling their products. On the contrary if they are engaged in marketing, production of the crafts will be hampered. In case of the artisans who practice lost wax process traders or middlemen supply the raw materials and also take the responsibility of selling their products. Thus location of market at a distant place cannot hamper their production.

Each area is studied in respect to their political boundary, geographical location, physiographic setting, which are also preconditions for development of the craft in the area. Physiographic and environmental condition influences the brass craft. It supplies suitable raw materials for the craft on the one hand and on the other hand it provides favourable condition for marketing their finished products. The area also has been studied in terms of facilities of civic amenities like educational institution, hospital and health care centre. They are living with other communities who live surrounding them and are maintaining a symbiotic relationship with each other. They serve other communities with their craft. Others also help them in different aspects of the craft.

Settlement pattern vary from one place to another. The houses are located by the side of the roads. In all the areas of study in West Bengal except in Bikna roads are metaled. The houses of the artisans are set in a linear fashion by both sides of the roads. Houses are brick built *pucca* and semi *pucca* and sometimes double storied. It shows that they have better economic condition. They have proper toilet facilities, Workshop are also *pucca* made of brunt bricks with tiled roofing. In Bikna settlement pattern of the houses are scattered in nature. Most of them live in wattle daub houses with thatched or tiled roofing. Village roads are not metaled, that is kutcha in nature. In case of Rathijemapatna in Odisha three types of houses are found such as *kutcha*-mud built, *pucca*-brick built and semi *pucca.* It shows that there is difference in economic condition in the village. Village Roads are almost *kutcha.* Houses are very congested encroaching on to the roads. In Sadeibereni, Dhenkanal district of Odisha, artisans are mostly living in wattle daub houses with thatched roof. Electric facility is not available at a stretch of time. Most of the time there is power failure. For this reason most of the works are performed during day time and in open air, outside their houses. In earlier times the Dokra artisans were nomadic in nature both in Odisha and West Bengal. They perambulated from one place to the other. Temporarily settled in one place and served people mainly for repairing of metal wares. At present government took initiatives to settle them in a particular place. The present a space where the artisans live are given by the Government both in Odisha and West Bengal.

Variation is found also within the communities. To understand the diversity of people associated with the brass craft, the population composition along with people in different villages and towns are studied. Study includes individuals, family, clan, marital status, age, sex, educational qualification and occupational pattern. Clusters are composed of different population groups. Brass working communities dominate in two areas i.e. Khagra in Berhampore district of West Bengal and Rathijemapatna in Khordha district of Odisha. Caste groups who are engaged in lost wax process of metal casting are marginalized and detached from the main village. This scenario is common in both Odisha and West Bengal. The nature of contact with other population is important for understanding of the relationship with other people in terms of their craft. Each

community maintains their solidarity in terms of marriage pattern and technology of making brass objects.

Most of the artisans live in medium sized families, which composed of four to six members. Small sized families and very large family type is absent in all of the areas of West Bengal and Odisha. All communities belong to Hindu caste groups. They are endogamous in nature, marriage outside their caste in prohibited. There are a few cases of out of caste marriage in West Bengal. This may be due to influence of modernization. However in Odisha it is strictly prohibited at present. In case of West Bengal brides are selected from far areas and also selected from the groups who practice similar technology. For example Kangasabanik living in Khagra area establish their marriage relationship with the Kangsabik of Nadia and Maldah districts. However the artisans of Kunjaghata in Murshidabad district and the Shibaloy of North 24 Parganas establish their marriage relationship mostly with the Kangasabanik group from Bangaldesh, because they had migrated from Bangladesh. They have similar technology for making brass pitcher. In Odisha brides are selected from adjoining districts as well as from the different hamlets of the same village. This is common occurrence both in Rathijemapatna in Khordha district and Sadeibereni in Dhenkanal district.

Age and sex wise distribution of population is made of each community. It is also related to the main working force necessary for the craft. It has been seen that process of making brass objects is very laborious and it is best at and around 20 to 50 years of age in urban areas. Males below 20 years engage in the craft as an apprentice after completion of certain level of education. Artisans above the age group 60 mainly practice less laborious jobs such as applying soldering material at the joints and sometimes polishing. In case of Rathijemapatna in Odisha artisans above 60 years age group mainly are engaged in operating the bellow and finishing of dice for box moulding. Women cannot participate in any sphere of the craft in Berhampore in Murshidabad district of West Bengal and Rathijemapatna in Khordha district of Odisha. Whereas, women are engaged in making of mould for casting of brass pitchers in Bishnupur in Bankura district of West Bengal. The scenario is different in case of lost wax process of metal casting. Both males

and females are engaged with the craft from their childhood both in West Bengal and Odisha.

Literacy level of the artisans is lower in rural areas compared to urban artisans. In urban areas they have opportunity for higher education and the artisans are also able to support the expenditure of education. Whereas in rural areas the artisans who practice lost wax process of metal casting are less interested for higher education because they can work with the craft from their childhood. The frequency of secondary education is highest in every areas of study. In case of Berhampore the level of literacy is also high and larger population are educated up to higher secondary and graduation level. Level of literacy among women is lower than the males in every area of study. An analysis was also done on the relation of occupation with education. The artisans of urban areas are keen on getting higher education so they are taking up stable and more paying jobs. Most of them are shifting to business and services. In case of Bishnupur artisans are not so educated that they may get white collar job and on the other hand there is no such opportunity in brass work. They are apprehensive about their future. Most of them are engaged as labour in the work. Besides brass work artisans are also engaged in business and daily labour in Rathijemapatna in Odisha. People of urban setting are keen on formal education than taking up their hereditary job. In case of lost wax process the scenario is totally different; they are keen on taking up their hereditary job both in Odisha and in West Bengal. Artisans of Sadeibereni engaged themselves as agricultural labour during rainy season when the production falls down. They also work as daily labour to sustain themselves as well as the craft.

Variations are found in different phases of technology. First is the collection of raw material. In case of wrought metal technique and sheet metal technique two primary ingredients necessary for the craft are brass scrap and fuel. These are collected from the nearby markets. It is also interesting to note that the communities selected for the present study mostly are engaged in making objects from brass. Bell metal only is used in two areas. One in the Khagra of West Bengal and another is the Rathijemapatna of Odisha. It shows that tin is scarce in eastern India.

In case of casting technology people have to collect clay. In most of the cases they collect clay from the river bank. It is also interesting that the habitations of the artisans are near to the river within 2 to 3 km from the village or township. In case of Berhampore the hamlets of artisans are concentrated by the side of the river Bhagirathi. In Bishnupur they live near the river Birai and in Rathijemapatna artisans are concentrated near the river Daya, which is a tributary of the river Mahanadi. The artisans selected the area for their habitation on the basis of nearby sources of clay and market for selling their products. In case of lost wax process of metal casting artisans have to depend on natural resources for collection of raw materials necessary for the craft. The primary ingredients are bees wax, different types of clay, paddy husk, jute, cow dung and fuel. As the profit from the craft is very low, they supplement their work with the locally available raw materials. Clay is mostly collected from agricultural field and termite hills. Bees wax and fuels are collected from the nearby jungle.

Making of brass objects need special skill which is traditionally learnt from one generation to the other generation. The techniques of making brass objects is primarily divided into two types, lost wax process of casting and other techniques. Other techniques include casting, wrought metal technique and sheet metal technique. An evolutionary model can also be built from the variation of technique of metal casting. Lost wax process is probably the earliest in origin because the brass objects found from archeological context in eastern India are made from lost wax process of metal casting. Next stage is the casting of bigger utensils by making clay mould. After that the process of shaping by alternate hammering and heating developed. Finally the introduction of the imported metal sheet led to the improvement in the organization of the brass craft. Earlier it was imported from England, now it is manufactured in different parts of the country. In West Bengal sheet metal is manufactured in Matiari in Nadia district. Introduction of sheet metal encouraged the production of brass wares (Sarkar 1993).

A spatio-temporal variation is noticed in equipment and tools used in brass craft. In case of Berhampore primary equipments are different types of hammers, stakes, pincers, snipers and a number of files for scraping of the objects. Tool types used by the

artisans of Shibaloy in North Twenty Four Parganas also have similarities with Berhampore. There is an introduction of new technology in Shibaloy i.e. the making of brass wares from dice operated by electrically operated machinery. It is also interesting that the tools and equipments used by the artisans of Rathijemapatna in Khordha district of Odisha resemble those of equipment used in Berhampore. It proves that similar technology need give rise to similar type of tools irrespective of geographical distance. Equipments used for the casting of brass pitcher have similarities with those of Berhampore but the technology of making mould is totally different. It is an elaborate process before the casting operation. In case of lost wax process of metal casting tools and equipments are simple and indigenous in nature. Tools are made by utilizing the natural resources. Two types of furnaces are found. Furnaces used for casting are comparatively larger that the furnace used for heating the objects for hammering. The furnace type of West Bengal is rectangular whereas in Odisha it is circular in shape. Furnace used for heating is circular and slightly elevated from the floor level both in Odisha and West Bengal. Wooden lathe used for scraping both in West Bengal and Odisha side by side with electrically operated lathe are also in use.

Finished products vary from one place to another. It depended on the demand of the society as well as on marketing. Diversification of products is also community specific. Kangsabanik of Khagra area is expert in making trays both from brass and bell metal. They engraved different types of designs on trays. Kangsabanik of Kunjaghata in Berhampore of Murshidabad district of Odisha and Shibaloy of North Twenty Four Parganas engaged in manufacturing of different types of pitchers mainly. They have common origin from the adjacent country Bangladaesh. Similarities of products help to understand the population migration and contact. Karmakars of Bishnupur are also engaged in making brass pitchers but shape, size and technology is totally different from Berhampore. Engraving is found both in Khagra area of Berhampore and Bishnupur. Whereas engravings are not done on the pitchers produced in Kunjaghata in Berhampore in Murshidabad district of West Bengal. Kansari community of Rathijemapatna produces diversified items, mostly household utensils and ritual objects. They are also engage in making images of God and Goddess from brass. The main difference between brass

objects of West Bengal and Odisha is the application of colour. Artisans of Rathijemapatna use metallic colour for attractive look of the finished objects.

In case of lost wax process of metal casting the artisans produce mainly ritual objects and decorative items. The main use of the Dokra items is at present for decoration purpose. They make different types of lamp shades, figurines of tribals, animals, and door handle etc. They are also applying a coat of metallic colour of gold for gorgeous look as their clients are form urban areas.

Change is an incessant process. Changes are found not only in the technology, but also raw materials and finished products. Artisans are always trying to sustain themselves with changes and demand of the society. Intention of adopting new technology is found among the younger generation than older population.

There are diversified rituals associated with the craft. Similarities and differences also have been found in different areas of the study. Karmakar of Bishnupur and Dhokra kamar of Bikna in Bankura district of West Bengal worship demigod Viswakarma on the last day of the Bengali month Bhadra (July-August). Same deity is worshipped by the Ghantara of Sadeibereni in Dhenkanal district of Odisha. It may also prove that they had common origin i.e. the Chotanagpur plateau. On the contrary Kangsabanik of West Bengal and Kansari of Odisha worship the Goddess Durga during Dushera festival in the Bengali month Aswin (September-October).

The brass workers are facing a number of problems relating to their health as well as the craft. Arthritis, breathing problems and skin diseases are common symptoms. Regarding the craft the main problem is the scarcity of brass because most of the metals are used for industrial purpose. This is common problems of all the artisans of West Bengal and Odisha. Other problems are dependency on middle men for raw materials and marketing of the finished products, backdated technology, high price of brass. For high price people choose objects of low weight. The traditional technology of making heavy weight material is also hampered. In spite of these the brass wares are continuing because of its reselling value and also concept of purity and hygiene. There is also belief in

Odisha that bell metal is not ritually pure, but brass is pure. So no object is offered to Lord Jagannath on vessels made of bell metal, except for a small bowl for serving ginger for digestion after lunch. In Berhampore in West Bengal there is also belief that tin (*Rang*) is mostly used by Muslim community, whereas Zinc (*Dasta*) is preferred by the people of Hindu religious faith.

A number of steps are taken by the State Government and Central Government for improvement of the craft and of the artisans related with the craft. Different fairs and festivals are arranged in district level as well as in state level, where the artisans can directly sell their products. Cooperatives are set up for supply of raw material, training of improved technology and also about the demand of the people and diversification of their products. The projects are running well in case of lost wax process both in West Bengal and in Odisha. But in case of other communities who practice wrought metal technique and sheet metal technique co-operatives are not running well because of the internal conflict. Middle men are also having their role for continuing of the craft. They help the artisans with supply of raw materials and also take responsibility for selling their products because artisans have no time for selling the products they produced. However the middlemen are criticized by the artisans in all the areas.

Present study is an attempt at throwing some light on the structural pattern and organization of the society in which the brass metallurgy are surviving. Not only the technology, but also skill and knowledge about the properties of different metals and reagents used for lowering of temperature and technique of making alloy from virgin metal are also sustaining the craft at present. The knowledge and skill which is inherited from generation to generation may contribute their best for the development of industries. Past technology of making brass objects also can be reconstructed with the help of this knowledge. In the present study a number of brass ornaments have been excavated from Keonjhar district of Odisha. These are made by lost wax process of metal casting. The remnants of crucible found from the site resemble the crucibles used by the contemporary artisans for lost wax process of metal casting in Dhenkanal district of Odisha. A study on

the Situlias in Palalhara area of Odisha is also made. The crucibles also resemble those found from the site of Keonjhar district.

Result of the present research can be concluded in the following points:

- The metallurgy of brass originated in eastern part of India during Chalcolithic period of time (c. 2000 BCE). Types of alloy and technology of manufacture proves that it is indigenous in origin with regional specialization.

- A number of communities practice brass work in different parts of eastern India at present. They maintain their solidarity by marriage pattern as well as with the use of common technology. The organization of production is an important aspect of the craft. It also depends upon particular social set up in which the artisans are surviving by maintaining a symbiotic relationship with other communities live in the area.

- Brass work is practiced as a community craft in indigenous way as well as with adoption of new techniques. Different techniques used are classified into four types such as lost wax technique, wrought metal technique, caste metal technique and sheet metal technique. Different communities practice different types of technology as per the demand of the society. Varieties of techniques also have effect on organization of production as well as norms and values associated with the craft.

- Surrounding geophysical settings is important aspect of the craft. The artisans can collect different raw materials and equipment necessary for the craft by utilizing the natural resources. In most of the cases these are collected free of cost.

- A number of problems have been identified. Problems are also varied according to the nature and technology of the craft. These problems are also responsible for slow transformation of the craft. These are as follows.

    - Scarcity of raw material and high price.

- Decreasing of demand due to high price of finished products and its maintenance.
- Traditional technology, which is more laborious and energy consuming.
- Competition with other cheaper wares in the market.
- Intervention of middle men or traders in the craft.
- Inclusion of other caste groups in the craft.
- Shortage of time for marketing the products.
- Scarcity of labour.
- Decreasing of natural resources due to deforestation.
- Insufficient capital for investment in the craft.

In spite of these problems the craft is being sustained at present. The techniques, skill, norms and values are also sustaining. This traditional knowledge is helpful for reconstructing the past technology. Not only are the present, but different aspects of past technology also are surviving with the present knowledge. This knowledge in combination is helpful to understand the emergence, diffusion and evolution of brass metallurgy and its contribution in the history of archaeometallurgy in the Indian subcontinent.

The research opens up the further research opportunity which can be conducted in other parts of the Indian subcontinent for understanding the regions of origin of different types of metals and its alloy, their diversity, migration and evolution which is culturally linked with Indian civilization.

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PLATES

Plate 5: Entrance of Kansari Para, Berhampore

Plate 6: Entrance of Kangsabanik Para, Berhampore

Plate 7: Entrance of Bikna Shilpa Danga, Bankura, W. B.

Plate 8: Entrance of the village Rathijemapatna Odisha

Plate 9: Entrance of the village Sadeibereni Odisha

Plate 10: A view of a worskshop in Shibalaya, W.B.

Plate 11: A view of a worskshop in Bishnupur , W.B.

Plate 12: A view of a worskshop in Rathijemapatna, Odisha

(i)

(ii)

(iii)

(iv)

(v)

(vi)

(vii)

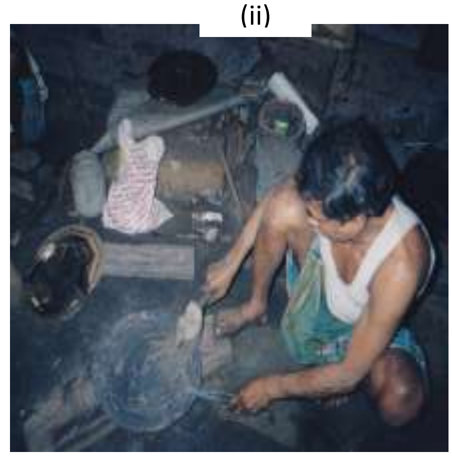
(viii)

Plate 13: Equipments used in brass technology in Berhampore, West Bengal
(i) pincers, (ii) hammers, (iii) files, (iv) Stake, (v) wooden mallet,
(vi) iron scrapers, (vii) crucibles, moulds and cover , (viii) lathe

(i)

(ii)

(iii)



(iv)

(v)

(vi)

Plate 14: Process of making plates in Khagra, Berhampore

(i) etching of shape, (ii) cutting, (iii) heating, (iv) hammering, (v) scraping, (vi) finished products

(i) Casting of ingots

(ii) Enlarging ingots

(iii) Shaping

(iv) Tempering

(v) Scraping

(vi) Forms in different stages

Plate 15: Wrought metal technique in Khagra, Berhampore

Plate 16: Finished products manufactured in Khagra, Berhampore, West Bengal

Plate 17: stages of manufacturing brass pitcher in Kunjaghata, Berhampore

**(i) making of mouth part, (ii) body parts, (iii) cutting of shoulder portion,
(iv) joining shoulder portion with neck, (v) welding, (vi) joining of middle part,
(vii) hammering, (viii) making of base, (ix) joing base with middle part, (x) hammering (xi) scraping, (xii) polishing**

(i) Hammer

(ii) Hollow iron

(iii) Iron engraver

(iv) Forming rim and neck

(v) Middle part

(vi) Base part

(vii) Welding

(viii) Polishing

(ix) Machine for moulding in dice (New addition)

Plate 18: Equipments, stages of making brass pitchers in Shibalaya, W. B.

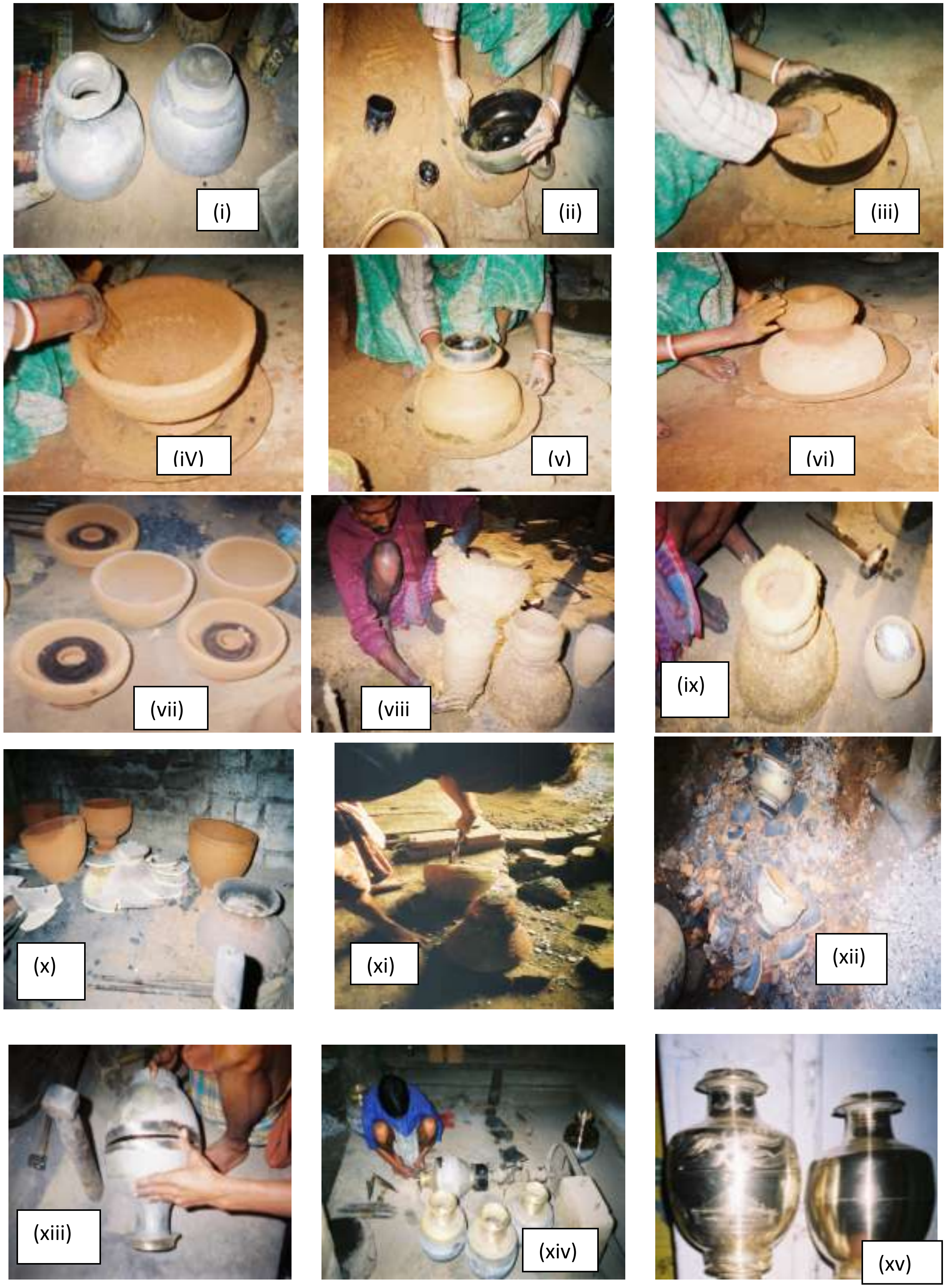


Plate 19: Stages of making brass pitcher in Bishnupur, Bankura, W.B.

(i) moulds, (ii) smearing of mobiles in the mould, (iii) making of inner mould, (iv) making of outer mould, (v) making of upper mould, (vi) making of top mould, (vii) dried up moulds, (viii) making of lower crucible, (ix) making of upper crucible, (x) casting, (xi) mould after casting, (xii) breaking of mould, (xiii) joining, (xiv) finishing, (xv) finished products

Plate 20: Stages of making glass (brass) in Bishnupur, Bankura, West Bengal

(i) making of moulds, (ii) finishing of moulds, (iii) different parts of moulds for making small pitchers, (iv) different parts of mould for making glass, (v) casting, (vi) breaking of brunt moulds, (vii) finished products after polishing

Plate 21: Source of lateritic clay used for making mould of brass pitcher in Bishnupur

Plate 22: Clay from river bed carried by bullock cart to the workshops of the artisans in Bishnupur

Plate 23: Stages of lost wax process practiced in Bikna, Bankura District, West Bengal

(i) collection of clay, (ii) preparation of wax, (iii) seiving of wax, (iv) making of clay moulds, (v) wax desgin, (vi) mould after wax design, (vii) covering with clay, (viii) making of crucible, (ix) casting furnace, (x) cleaning after casting.










Plate 24: Finished products of Bikna, Bankura Ditsrict, W.B.

& Selling of dhokra objects in fair in kolkata

(i)

(ii)

(iii)

(iv)

(v)

(vi)

(vii)

(viii)

(ix)

Plate 25: Equipments used for making brass objects in Rathijemapatna, Odisha

Wrought metal technique- (i) hammers, (ii) pincers, (iii) iron scrapers
Equipments used for box moulding – (iv) spoons, (v) wooden poles, (vi) compass
(vii) pipes, (viii) Brush, (x) buffing machine

(i)

(ii)

(iii)

(iv)

(v)

(vi)

(vii)

Plate 26: Different stages of wrought metal technique in Rathijemapatna, Odisha (i) enlarging ingots, (ii) heating, (iii) shaping, (iv) raising of edges, (v) final shaping, (vi) scraping, (vii) polishing

Plate 27: Dice for making brass images in Rathijemapatna, Odisha

(i)

(ii)

(iii)

(iv)

(v)

(vI)

(vii)

Plate 28: Technique of casting in box moulding in Rathijemapatna, Odisha
(i) filling of box with clay, (ii) measurements, (iii) making of mould,
(iv) making hole, (v) covering the box mould,
(vi) melting of metal, (vii) casting in mould

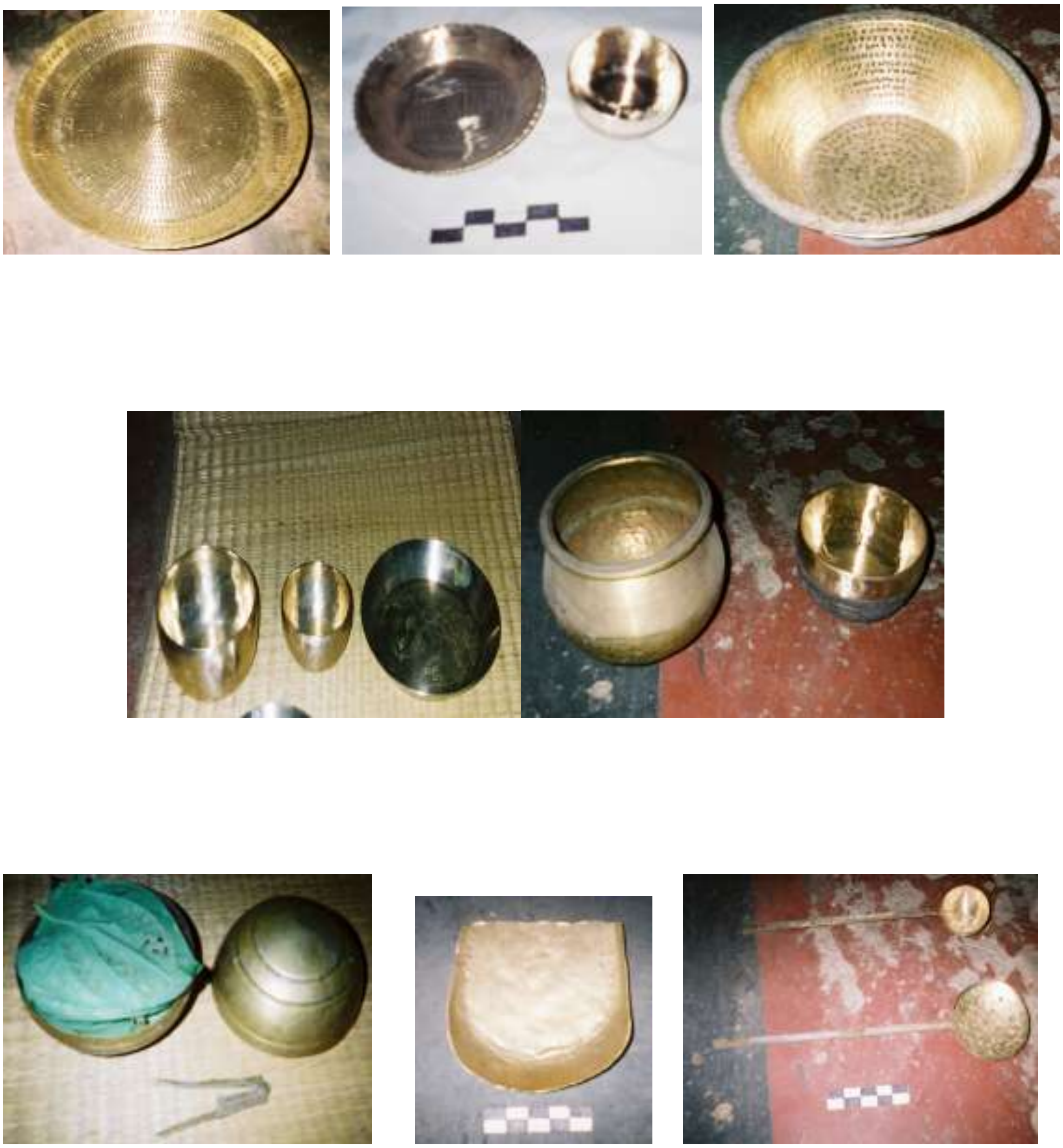


Plate 29: Different household utensils made in Rathijemapatna, Odisha

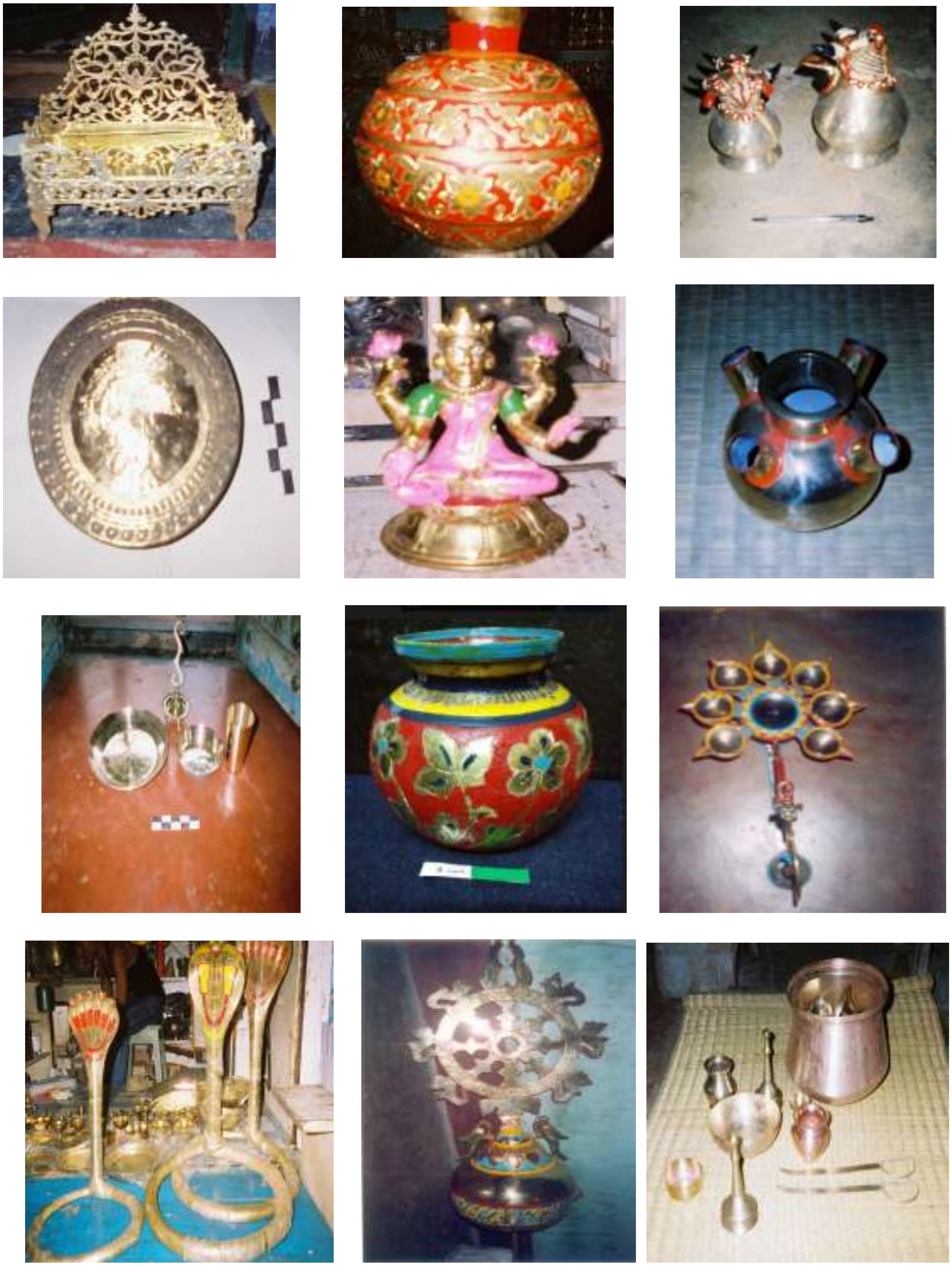


Plate 30: Ritual objects made of brass in Rathijemapatna, Khordha District, Odisha

Tools used for making design

Wooden press

Bellow, wooden pincer, stick

Clay from agricultural field

Clay from termite hill

Mixing of clay

Preparation of wax

Wax threads

Design of wax thread

Plate 31: Equipments and raw materials used in lost wax process of brass casting in Sadeibereni, odisha

Making of wax model

Designing

Pouring in water

Ready wax model

Covering with clay

Covering the back portion

Making of crucible

Filling with brass scrap

Covering with clay cap

Process of casting

Removing from furnace

Product after casting

Plate 32: Stages of solid casting process in Sadeibereni, odisha

Making of clay model

Designing with wax threads

Covering moulds with clay

Application of coating of clay

Making of crucible

Plate 33: Stages of hollow casting in Sadeibereni, Odisha

Plate 34: Brass objects made by lost wax process of casting in Sadeibereni, Odisha

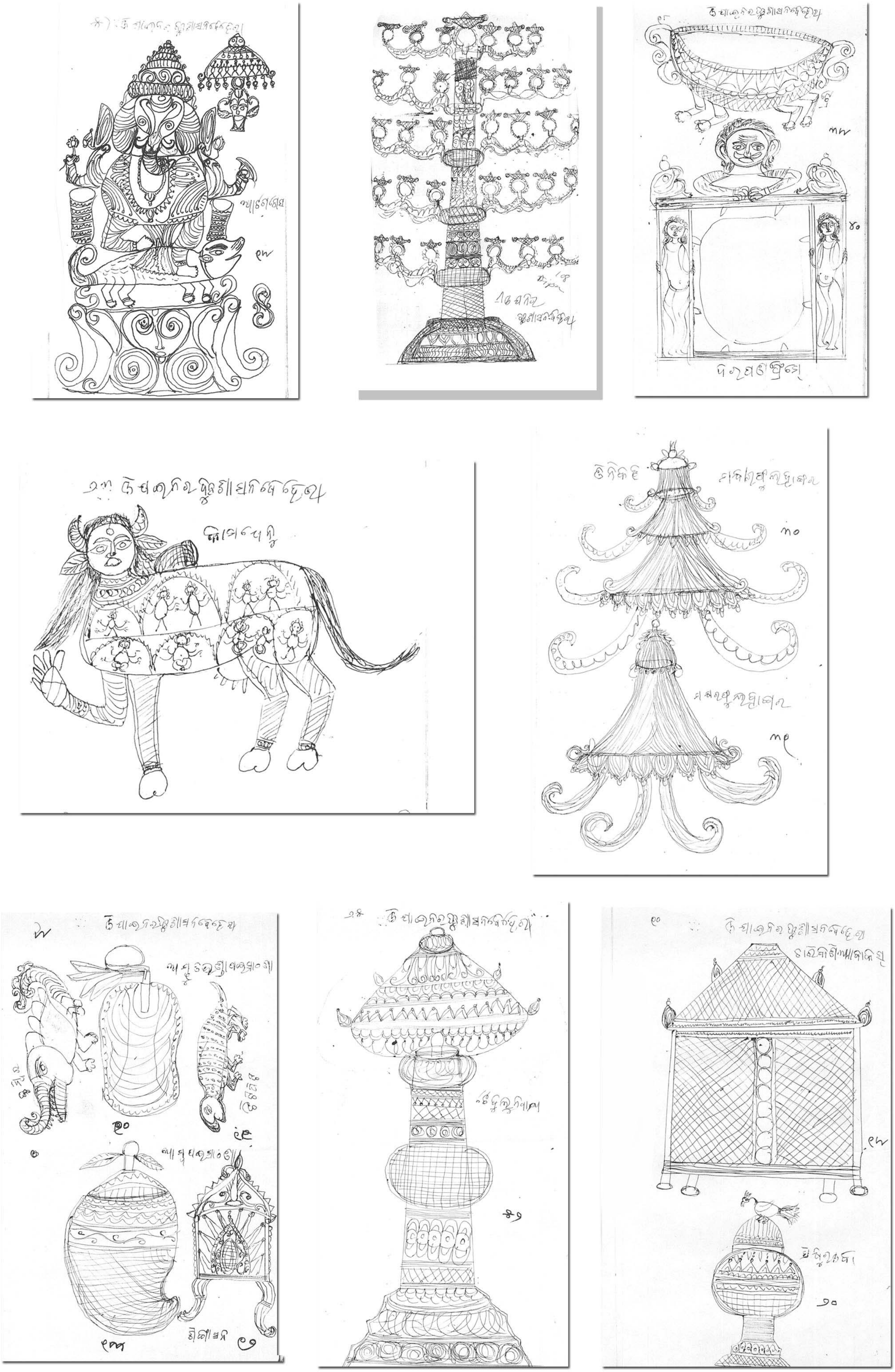


Plate -35 Sketechs drawn by the artisan of Sadeibereni, Odisha-

(i) Furnace of Berhampore, W.B.

(ii) Furnace for casting of glass in Bishnupur, W.B.

(iii) Rathijemapatna, odisha
Furnace used in wrought metal technique

(iv) Rathijemapatna, Odisha
Furnace used in melting of metal

(v) Furnace usd for lost wax process in Sadeibereni, Odisha

Plate 36: Different types of furnace in different clusters under study

Plate 37: Collection of data from informants